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INDEX TO VOLUME XII.

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The titles first appearing under each classification head are those of leading articles in the Magazine. The titles in smaller type, which follow, indicate articles from other journals which have been editorially noticed in the "Review of the Engineering Press." The asterisk (*) marks the occurrence of illustrations.

ARCHITECTURE AND BUILDING.

REVIEWS.

CIVIL ENGINEERING.

REVIEWS.

ECONOMICS AND INDUSTRY.

PAGE.

REVIEWS.

ELECTRICAL ENGINEERING.

REVIEWS.

MARINE ENGINEERING.

REVIEWS.

MECHANICAL ENGINEERING.

REVIEWS.

MINING AND METALLURGY.

REVIEWS.

MUNICIPAL ENGINEERING.

REVIEWS.

RAILROAD AFFAIRS.

REVIEWS.

MISCELLANEOUS.

REVIEWS.

BOOKS RECEIVED AND REVIEWED.

THE

ENGINEERING MAGAZINE

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OUR NATIONAL POLICY AND THE INDUSTRIAL OUTLOOK.

By Cuthbert Mills.

TO review and forecast the industrial situation in the light of the expected sound-money victory in November involves certain preliminary considerations. (1.) Will there be such a victory? (2.) Will the victory be merely an escape from defeat? (3.) Or will the defeat of the Bryan party be complete and overwhelming? It would be rash to predict any one of these events. We hope for the first and the last; but it is plain that, if we get only the second, conditions only slightly improved will continue to confront us. No prudent business man is justified in assuming at this time that he will not be called upon to meet such a state of affairs as would follow from a sound-money victory won only by a scratch. If he adjusts his business to such a contingency, he will be at least safe; and, if the defeat of the silverites be thorough, he will be so much better off. Therefore the part of prudence is to be prepared for a period of difficulty, while assuming that McKinley will be elected; for it is hard to see how all our industrial and financial troubles are to be removed merely by the fact of his election.

We must, anyway, take the chances of Bryan's success. What would be the full consequences of that no man can tell, but for a time there would be something like chaos. It is a risk which we are forced to take, and from which there is no escape. But let us first assume that he *is* defeated; second, to be on the safe side, that McKinley's vote in the electoral college is barely enough to elect him. In such an event the *morale* of the silver party would be but slightly impaired. In the house it would, of course, be powerless. The strength of the sound-money party there is not likely to be much less than it was when the Sherman act was repealed. But in the senate, the stronghold of silver, there would be no break in the ranks. The advocates of free silver would be encouraged still further to continue their fight, from the fact that their presidential candidate had come so near to success on this very issue. The result would be a deadlock on all legislation affecting either finances or the tariff.

Such a block could not fail to have a most injurious effect on business. It would not prevent a partial recovery from the state of industrial paralysis from which the country is now suffering, since this comes from an apprehension that the worst may happen,—*viz.*, the election of Bryan; but, on the other hand, it would greatly retard the recovery and probably leave it incomplete. Confidence cannot wholly return, until it is seen that the treasury is safe against the practical exhaustion of its gold reserve.

This is a problem we shall have to face before the next president is inaugurated, whoever he may be. It is full of difficulties, which have been largely increased by the trade conditions brought about by the Chicago convention. One effect of them has been to severely cut down the imports. The immediate consequence of this is beneficial, in that it checks the demand for gold to pay foreign sellers. But on the other side it is bad, because the government revenues are mainly derived from customs duties, and the decrease in imports carries with it a corresponding decrease in the government income, while the expenditures, fixed by law, remain the same. The government, therefore, must struggle with a diminishing income, which, on the assumption of a deadlock in congress, cannot be increased by added taxation.

The present administration, having a large reserve of currency in the treasury (but not of gold), may avoid the unpleasant expedient of making another bond issue, since it can meet deficiencies by paying out greenbacks it now holds. If there be no drain upon its gold through domestic hoarding, it may gain somewhat in its gold holdings, because the trade balance sends gold this way in the fall of the year. But with the return of spring the export of gold usually begins. If the senate should continue to refuse relief to the treasury, the situation may again become critical enough to give a check to business, and produce effects not greatly different from those we have recently suffered from. This, it must be confessed, is an unpleasant prospect; but it is useless to try and disguise from ourselves a contingency which we shall certainly have to face if McKinley be elected, but by a vote barely enough to carry him through.

It is, therefore, of almost as much importance, from a business standpoint, that the vote which carries him in be so large as to overwhelm the silver party, as that Bryan should be defeated. A half-victory, with things as they are, would put the sound-money party at a serious disadvantage, in that it would find itself powerless to effect the needed reforms in legislation which are absolutely essential to putting our currency on a sound basis and giving to business interests the needed stability.

On the other hand, let us suppose that we have a sound-money tidal wave; that the vote be such as to leave Bryan only the conceded silver States of the extreme West and of the South. Suppose that his defeat be as complete as that of Greeley in 1872. In this case, the revulsion of popular feeling would leave the silver party in the senate not only in a hopeless minority, but disheartened and unnerved by the thrashing they had received. The forces of obstruction would melt away. Even the Democratic senators who had acted with the Bryan party would feel that they had submitted their policy to the popular verdict, and that the verdict had been one of overwhelming condemnation. They would have the physical power still to obstruct, but the moral force would be wanting. The only party remaining which would still have any vital force would be the small band of senators from the mining States, with whom the question would still be one of their pockets. Their power for effective harm would have gone, when they were left alone.

Supposing that we have such a victory as this implies, it is reasonable to look forward to a rebound in business corresponding to the depth of the previous depression. We should not have to wait till the new congress came in, either in extra session called by the new president, or in regular session in the December following his inauguration. The anticipated changes for the better would be "discounted" in advance by an industrial revival probably equal to that of 1879-80.

The chances are that the outgoing administration would not propose to the congress which meets in December any new legislation; or, if it did, it would be merely of a tentative character, designed to meet such emergencies as might arise before March. It would be natural to leave to the new administration the task of inaugurating or suggesting more radical measures.

What are these measures likely to be? The first, and one upon which all parties (except the irreconcilable silverites) will agree, would be one designed to give the treasury more revenue. It is conceded that the present revenues are insufficient. The treasury is paying out more than it is taking in, and the close of the fiscal year must inevitably see a large deficit, to meet which the treasury will have had to draw on its accumulated surplus, largely made up from the proceeds of bond sales. The dispute will come over the details of such a measure ; and the end will probably be reached by compromise. It is not to be supposed that any measure of an extreme protective character will be proposed, or, if proposed, could be passed. Protection is only an incidental issue in this campaign. The sound-money Democrats, who will contribute to McKinley's election, are not protectionists, and the Bryan party are not. Furthermore, the Republicans have had all they want of extreme high protection, and unmistakably are not inclined to try any more of it. Therefore, we may look to see a spirit of compromise displayed by both parties, and a measure for increasing the revenue adopted which will cause as little business disturbance as possible. The St. Louis platform plainly intimates that this is to be the Republican policy.

When it comes to dealing directly with currency measures, as apart from questions of revenue, it must be conceded that we are entering on more debatable ground. There is no unanimity of opinion in any party as to exactly what should be done,—that is, no unanimity outside of the Bryan people, who propose their free-silver cure for everything. There is no question definitely before the people now as to the lines on which our currency system shall be reformed, and therefore it cannot be said, after Bryan's defeat, that the country has said how such a reform shall be carried out. The only question that will be settled is whether or not we are to have free coinage of silver. It is possible that, in view of the diversity of opinion, congress may decide to appoint a commission of inquiry ; and that, the immediate needs of the treasury being provided for, no action will be taken on purely currency matters until the commission has made its report. If the make-up of the commission be good, and such as to inspire public confidence, its appointment would have a beneficial effect. It would be felt that nothing was going to be done in a hurry, and no rash experiments tried.

It looks as if it were certain that congress will have to be called in extra session as soon as the new president is inaugurated. If such a calamity as Bryan's election should befall the country, it is certain that he would call it ; in the nearly certain event of McKinley's success, it is difficult to see how he can avoid it. But we are now speaking on the assumption, not only of McKinley's election, but of his election by such a vote as will overwhelm the silver party. On this assumption, which supposes the silver party crushed, business will not wait for congress. The incubus of the silver scare being thrown off, the industrial forces of the country will spring into renewed activity, and the danger is more that there will be a sudden and enthusiastic expansion than that depression will continue. The idea, however, that foreign capital will rush into the country in untold volume is fallacious. The foreign capitalist is not operated on by the same forces; he will be inclined to wait, to be cautious, and to satisfy himself that the improvement is permanent, before he ventures freely. But this will not retard the forward movement here. The domestic trade revival will be immediate.

How long shall we have to wait before this revival manifests itself? Probably less than two months,—that is, assuming that the indications become plainer that Bryan will be defeated. It may be considered certain that the election will bring out an extraordinarily large vote, probably the largest ever polled at a presidential election. Usually, when so large a vote is brought out, the results are of a very decisive character. We shall doubtless have some certain indications of what the results will be before the voting is done. Assuming that these indications are favorable to the sound-money party, we may look for a perceptible improvement in the industrial situation by the middle of October.

While no man can predict in detail what will be the industrial consequences of a sound-money victory in November (any more than he could the consequences of Bryan's election), we may, in the event of such a victory, surely expect some relaxation of the rigid retrenchment and repression which have characterized all industrial enterprises during the period of uncertainty. We can expect that the lessons of economy and close management learned during the bad years will bear fruit in the ability to conduct business profitably on closer margins; and that, as this is proved, the business ventures of the country will again move forward with a more nearly normal progress, on a sounder basis in themselves, and with less to suffer from wild-cat competition. A verdict of the country for sound money must necessarily rehabilitate our credit, at home and abroad, and loosen the now closed purses of the financial backers of industrial enterprise.

FAST TRAINS AS RELATED TO BUSINESS POLICY.

By H. G. Prout.

RUSKIN and our revered grandmother never had even a glimmering of the service of railroads to humanity, and their imagination remained forever dead to all that is stirring and grand in railroads, either physically or morally. Ruskin, with that moderation of thought and statement which his readers know so well, said: "I should like to destroy most of the railroads in England and all the railroads in Wales." To him the railroad was an evil thing, not alone because it disturbed the sweet serenity of nature, and because it was at best hopelessly ugly, but because of its debasing effect on humanity. The railroad was one of those instrumentalities which are destroying the independence, the gayety, the multifariousness of the individual man, and making him a poor, contracted little unit in the great machinery of life. Instead of wearing a picturesque velveteen jacket and singing in the fields and doing a variety of honest work, most of which he must contrive with his own head and carry out with his own hand, the modern man in a society modified by railroads is a pale and dirty and unpicturesque tender of machines, toiling among piles of bricks and mortar. Our grandmother never went so deep into the subject as Ruskin. To her the railroad was something which made a horrible noise, and destroyed her peaceful orchard, and scared away the birds and killed people in a dreadful way.

One must often sympathize with Ruskin and with our grandmother in these feelings toward the railroad, and yet they were not altogether right in their opinions, even on the esthetic side. There are few things more impressive than a great express train thundering along through the darkness. How it roars, how it flies, how the earth trembles beneath it! Surely the man who can stand without emotion beside the track and see it pass has but a feeble imagination. There is but one other thing that so impresses me with man's control of "the great sources of power in nature," and that is to stand of a dark and blustering night on the deck of a great ocean steamer, and hear the wind sing in the stays and see the black water rush past.

But in this age of the world the esthetic side of the railroad will seem to most persons of very trifling importance. The serious way to consider the railroad is with regard to its services to humanity, and here most of us differ radically from Ruskin and from our grandmother.

In a wise and brilliant address delivered to a very distinguished company a few years ago Mr. Abram S. Hewitt said: "The Bessemer invention takes its rank with the great events which have changed the face of society since the time of the middle ages. The invention of printing, the construction of the magnetic compass, the discovery of America, and the introduction of the steam engine are the only capital events in modern history which belong in the same category as the Bessemer process." Through Bessemer's discoveries "the cost of constructing railroads has been greatly lessened, the cost of transportation has been reduced, and the practical result has been to reduce the value of food products throughout the civilized world; and, inasmuch as cheap food is the basis of all industrial development and the necessary condition for the amelioration of humanity, the present generation has witnessed a general rise in the wages of labor, accompanied by a fall in the price of food which it consumes. The working classes of our day are enabled to earn and to expend at least double the amount which was at their command in any previous age of the world. Sir Henry Bessemer has certainly been the great apostle of democracy."

It is not necessary to develop Mr. Hewitt's idea further. The great service of railroads to humanity has been in two principal ways: first, and most important, in reducing the cost of carrying materials and persons over the face of the earth; second, in making communication swift and comfortable. With the first we have nothing to do here, but I am charged by the editor of the ENGINEERING MAGAZINE with the task of telling something of the effects on humanity at large of increased passenger-train speeds, and especially of their effect on the business of the railroads themselves.

Frankly, I may say at the outset that I have only a very vague notion of what these effects have been. I have the less hesitation in making this confession because I am satisfied that no one else has anything but a vague notion. The whole inquiry must be more or less speculative, but, to bring it down for a moment into the realm of solid fact, in which my essentially unimaginative mind much prefers to dwell, we will attempt to get some measure of the increase of passenger-train speeds in recent years.

In 1880 there started from New York for Buffalo 10 trains every day which can be classed as regular passenger trains, besides emigrant trains, which latter we will leave out of the consideration. These trains ran over three different roads. The fastest of them made the journey from one terminus to the other in 14 hours, or at 31.4 miles an hour. The slowest ran at 21 miles an hour and was 21 hours on the way. The average speed per hour of these 10 trains was 26.3 miles an hour. In midsummer of 1896 there are running from New

York to Buffalo 25 passenger trains every day. These run over five different routes. The fastest is, of course, the Empire State express, which is timed to make the journey from one station to the other in 8¼ hours, or 53.3 miles per hour. It is not only timed to do this, but does it, summer and winter, year in and year out. The slowest train that we find running from New York to Buffalo makes 26.6 miles per hour. The average of all is about 34½ miles an hour.

In 1880 there were 14 trains starting out of New York every day for Chicago. The fastest of these made the journey at the rate of 27.1 miles an hour, and the slowest at 25.1 miles. The average speed was 26½ miles an hour. In the summer of 1896 there are 24 trains starting from New York for Chicago every day on eight different railroads. The fastest of them makes 39½ miles an hour, the slowest 26.1, and the average is 31.8.

The regular passenger trains starting daily from New York for Philadelphia in 1880 numbered 28. The highest speed made was about the same as the highest in 1896,—namely, 44.8 miles an hour. This includes one mile by ferry, which absorbs 13 minutes. The slowest train in 1880 ran at the rate of 18.7 miles an hour. In 1896 there are 47 trains running: the highest speed is 45.6 miles an hour, the slowest 16.3

From Chicago to Milwaukee the number of daily trains running in 1880 was 8, the highest speed 31 miles an hour, the slowest 25.3 miles, and the average 28.3. In 1896 the number of trains running out of Chicago for Milwaukee every day is 15; the highest speed is 39.2 miles an hour, the slowest 29.1, and the average 38. From Chicago to St. Paul the total number of trains starting every day in 1880 was 4. The speed was 24.8 miles an hour for the fastest, 22.1, for the slowest, and the average 22.2. In 1896 the number of these trains is 15 a day, the highest speed 32.6, the slowest 24.5, and the average 30 miles an hour.

Of course, this comparison could be carried on almost indefinitely, but it is a laborious one to make and these examples are enough to give a pretty accurate notion of the advance in service to the public, both in the number of trains and in their speed. The trains from New York to Buffalo have increased 2½ times in number and 31 per cent. in average speed. The speed of the fastest train has increased almost 70 per cent. From New York to Chicago the trains have increased 71 per cent. in number and the fastest have gained 45 per cent. in speed. From Chicago to St. Paul the number of trains has almost quadrupled, and the best speed has increased 31 per cent.

Having thus got some measure of the growth in the number of trains and in their speed in the sixteen years considered, we may properly inquire whether or not passenger travel has increased accordingly.

Unfortunately, we have not the passenger-miles for 1880. The first compilation made by Poor, of this indispensable unit of measurement, is for 1882. In that year the total passenger journeys made on the railroads of the United States amounted to 289,000,000. In 1895 the total passenger journeys were 507,500,000. The passenger-miles in 1882 were 7,688,500,000; in 1895 they were 12,188,500,000. The absolute increase in passenger movement is obvious enough from these figures, but was there relatively a greater passenger travel in the later year? In 1882 each individual inhabitant of the United States took 5 1/2 journeys by rail; in 1895 he took 7.2 journeys by rail. Or, using the more accurate measure of distance travelled, in 1882 each inhabitant travelled 146.7 miles, and in 1895 he travelled 174.1. It is sufficiently apparent from these figures that the use made of the railroads of the United States by the people of the nation increased greatly in the years considered; but so did the supply of railroads. Per mile of railroad in operation, the travel was actually less in 1895 than it was in 1882; that is, in 1882 there were 80,300 passenger-miles travelled for each mile of railroad worked, and in 1895 there were 67,400 passenger-miles for each mile of railroad. In other words, the public use increased, while the returns to the railroads decreased, all of which could be shown by figures into which we need not go.

We have now some rough measure of the increase of service rendered, and of the increased use made of the railroads by the public; but what does it all prove? Is the increased travel the result of higher speed, or is the increased speed the result of more travel, or are both the results, partly of each other, and partly of a great many other things? Any deduction from the figures alone will depend a good deal on the way the figures are arranged. But let us approach the subject by reason alone, setting aside for the time these figures, which, while they might furnish ground for much entertaining speculation, are not likely to help us in the search that we have undertaken,—namely, to find how train speed affects the volume of travel.

Probably increased speed is of more importance to those who live in the suburbs and do business in the great cities than to any other class. To these people a small gain in speed means a great gain in time. For instance, a man who lives about 15 miles away from the city terminal station will travel, going to and from his business, about 10,000 miles a year. The difference between 24 miles an hour and 36 miles an hour average speed will be a difference of 50 seconds per mile traveled, or, say, 140 hours for 10,000 miles, or 17½ days in a year, counting the business day at 8 hours, or 14 days a year for the mechanic or clerk who works 10 hours a day. Such an increase in average speed would be to the suburban dweller a clear gain of more than half a month in each year, which would be available to him for business or for pleasure. It might make a difference of more than two weeks in his annual vacation, or it might make a difference of the income of more than two average weeks in the results of his business.

Or, we may look at this matter in another way, and assume that the time which the suburban dweller is willing to spend in travelling is fixed. Then an increase of fifty per cent. in the speed of the trains which serve him increases by that much the zone in which he can choose his home, giving him command of a greater variety of conditions, such as rents, taxes, schools, roads, water-supply, topography, etc. Or, such an increase of suburban train speeds will raise the value of real estate within a certain zone, and thus add to the common wealth.

All of this is so obvious that it seems superfluous to say it. It is equally obvious that, as increased speed of suburban trains adds to the wealth and to the comfort of mankind, so it will add to the revenues of the railroads themselves; and it is obvious that, other things being nearly equal, the railroad that gives the fastest service will be preferred by suburban residents. The result is a rapid development of its suburbs and its suburban business. A thin suburban traffic is a bad business. It is done at a loss to the railroad, and is unsatisfactory to the commuter, and the service must, in the nature of things, be poor. A dense suburban business is probably profitable. It is easily handled, considering its volume, and is likely to be as nearly satisfactory to the commuter as it can be made. But I have yet to know more than about a dozen satisfied commuters, and my knowledge of them is extended.

A characteristic instance of the increase of suburban speeds and of its effect comes from one of the big railroads entering Chicago. In eight years the average speed rose from about twenty miles to about thirty miles an hour, and in that time the volume of the suburban business more than doubled; but "the increase is certainly not due entirely to improved train service; more largely to other conditions."

There is still another advantage in high speeds for suburban trains. It is probably the best and the most available way of meeting the tremendous and inevitable competition of the trolley roads. For short distances they have advantages which it seems impossible to overcome. Their cars can stop anywhere to pick up passengers; they run so frequently that the passenger does not need to consider a time table, and they go within a few yards or rods of his door. Until trolley roads are driven off the highways,—which event is so far in the future that it is not worth considering,—steam railroads cannot compete with them generally for the very-short-distance suburban business; but, as distance increases, the higher speed which can be made by a railroad running its trains on its own right of way, free from the dangers and interruptions of a public highway, will, at some point, begin to offset the convenience of the trolley road.

But, after the suburban zone is past, it seems, as a matter of reasoning, as if increased train speed would have little effect on the volume of travel until some long distance is reached. The gain of time in each mile can have a real economical value to the passenger only when it is multiplied by a great many miles, either because of the frequency of his journeys or because of the length of a single journey. So, for middle distances, it is doubtful if speed will increase travel much. Of course it is a very important matter in competition, but that it actually stimulates movement is doubtful. For instance, if the journey is 100 miles which the farmer, or the village storekeeper, or his wife, must take to go to the nearest large city for business or pleasure, or which one must take to get from one large town to another, the speed of the train probably has little to do with the number of the journeys. The difference between 30 miles an hour and 45 miles an hour is about two hours in the round trip; but, at best, to take the journey and to do a little business will break up a day, and the fare, at this distance, becomes an important sum, and two hours more or less does not decide whether or not the journey will be taken. The saving of time adds to the comfort of the passenger, and it adds to the wealth of the community, but it is doubtful if it adds much, or anything, to the revenues of the railroad. At any rate, we have considerable testimony that increase of travel has not been proportionate to increase of service for middle distances.

All these considerations grow in importance as distances increase, until we get up to some distance at which the time saved again becomes a factor that will decide in many cases whether or not one takes the journey. But, even among the short, middle-distance journeys, there may be some exceptions to our reasoning. For example, we may take cases like New York and Philadelphia, or Chicago and Milwaukee, or the large towns on the line of the New York Central. In all of these large towns there is a considerable number of men whose time is valuable, who may be tempted to take more journeys if the round trip occupies four hours than they will take if it occupies five hours and a half. The Empire State express, for example, is said to have *created* a certain traffic, because men could go from one town to another and back and have some time during the business day in each of the two towns at the ends of their journey. But even in these cases the difference between the speed of the fastest train and that of the ordinary trains, when multiplied by the distance traveled, amounts to so little in time saved that it is not likely that it has much influence on the volume of travel. Convenient hours and frequent trains are probably a great deal more important factors in increasing travel for those distances. But, when we get trains running between Jersey City and Philadelphia, or between Chicago and Milwaukee, at an average speed of 75 miles an hour, between termini the traveler will be able to save an hour and a half in the round trip. Then probably more journeys will be made, because of this one fact of better speed.

When the travel approaches 1,000 miles,—as, for example, from New York to Chicago,—every increment of the average speed has a meaning which it cannot have in short journeys. The difference between 26 miles an hour and 40 miles an hour is the difference of a whole working day. Or, it is the difference between a night spent in your own bed and a night spent on a sleeping-car. Obviously, such a difference must have an effect on the volume of travel. We cannot doubt that passenger movement is stimulated by the reduction of the time spent on the journey, but we cannot prove it.

In 1893 an experiment was tried from which many of us expected a good deal. In that year the New York Central Railroad and the Lake Shore put in service the famous "Exposition Flyer," which made the journey between New York and Chicago in 20 hours' actual time; or apparently in 19 hours' westbound and 21 hours' eastbound. The distance run was 964 miles, making the average speed 48.2 miles an hour, including nine stops, in seven of which engines were changed. This beautiful performance was enough to excite the enthusiasm of any person at all appreciative of the difficulties and excellencies of railroad work and capable of enthusiasm. In writing of the establishment of this train, I said: "While it is foolish to tempt fate by making a gratuitous prophecy, I should not be at all surprised to see the run between New York and Chicago made regularly in 18 hours within the next two years." There seemed to be excellent business grounds for such a reduction of time. Thirty-six hours between New York and Chicago meant (if one started in the evening) simply spending two nights on the way; it meant the loss of only one working day; and, to the hardened traveller, two nights on the way was no very serious matter. A reduction to 24 hours or 25 hours was, for most people, no saving of time, although it was a measurable addition to one's comfort; you still lost one working day. But, when the time was reduced to 20 hours, one could do a fair day's work in New York, leave there at 3 o'clock, arrive in Chicago at 10 o'clock the next morning, spend 4 hours in Chicago, leave there at 2, and be in New York again at 11 o'clock the next day. This journey I actually performed. I was away from New York 44 hours, and, by a little use of the telegraph, had four profitable hours in Chicago.

Here, one would say, was a reduction of time of real human value. It permitted one to do business in the two great cities in three consecutive days. It did not seem too much to suppose that it would induce a new movement of passengers, or, as folks say, "create traffic." In fact, however, the train was withdrawn at the close of the World's Fair, and in the three years that have passed since then there has been no reduction of time : which shows the risks taken by him who ventures to prophesy.

But this case really proves nothing. In the middle of 1893 the currency panic developed, and from that day to this our suffering nation has not been permitted to recover and to go on about its business under conditions of normal health. It is quite possible that, if business had been ordinarily good for the last three years, we should now have regular trains running between New York and Chicago at 50 miles an hour, including stops, and that these trains would pay. This would make the actual time between New York and Chicago 19 hours and 20 minutes by the New York Central, and 18 hours and 15 minutes by the Pennsylvania railroad. As, for good business reasons, the through time is held the same, the Pennsylvania would run a little slower, and make the 19-hour schedule. There are some topographical reasons why the Pennsylvania would be very willing to do this.

The attention of the public has been much occupied the last three or four years by accounts of very fast runs made for long and short distances, by regular trains as well as by special trains, and we are naturally led to inquire somewhat into the advertising value of high speed. Doubtless, it has a considerable value of this sort, but its value must be chiefly in securing competitive traffic and not very great in creating new traffic. The public knowledge that some of the trains of a certain railroad make extraordinarily fast time, advertises all of the trains of that railroad and this knowledge has an influence in diverting competitive travel. But even this is a matter to be considered with great caution. Other things being equal, the faster trains will take more passengers : but there are a great many other things that must be equal. Convenient hours, frequent trains and the regular fulfillment of the promise of the time-tables are all conditions that must be carefully borne in mind ; and a condition as important as any and perhaps more important than any of the others, is the comfort of the passenger on his journey. Very likely the sum of all these conditions is considerably more important than speed alone. All of us must have met travellers, and particularly ladies, who have been made uncomfortable and even ill by being dragged fast over a crooked road and who have, ever after, preferred a slower train ; and there are various other ways in which speed interferes with comfort. For instance, if a fast schedule involves making a long run without a dining-car, and subjects passengers to the costly antiquities of a "buffet-car" lunch, we may be sure that that train will soon acquire a bad name among discriminating travellers. It would be indiscreet to name names here but the experienced reader can supply instances.

A fast schedule made at the expense of punctuality in arriving may do more harm than good; there are intelligent passenger agents who have no doubt that it does more harm than good. There are few things that irritate a passenger so much as to arrive behind time and few things that give the service of a railroad so bad a reputation.

Beyond all this we must remember that fast trains are a very expensive form of advertising. They must not only be run, but the public must be kept forever aware that they are run; that is, the trains themselves must be advertised. On the whole, even this aspect of our inquiry is not so simple as it seems at first thought.

Probably it is not worth while to follow this line of speculation any further, for, after all, it is mere speculation, and whether or not any man's conjectures on the subject are of interest or value depends on the strength of his imagination and on the knowledge of actual conditions which he can bring to the control of that imagination.

In looking over this article, three principal things seem to have been accomplished; (1) the fact has been made clear that in recent years there has been a great increase in passenger-train speeds, which we all knew, or thought we knew, before; (2) it has been shown also that passenger movement, actual and relative, has likewise increased to a very notable degree; and (3) it has been made quite apparent that the writer of the article is entirely unable to point out the relations between (1) and (2). In justice to him, however, it should be added that he has probably suggested the law of the social uses of high speed,—namely, that high speed is really useful to mankind only when the increment of speed is multiplied by many miles, either because of frequent journeys or because of very long journeys.

Finally, when one speculates on this subject of the causes of the growth of railroad travel, he should not forget one great influence which has not yet been mentioned; – an influence which on some railroads seems to be more important than all others. That is the influence of the man who sits up nights thinking how his railroad can be made useful and attractive to the public and how the public can be taught that it is useful and attractive,—the man who spends active days carrying out the schemes which his fertile brain has contrived. We must never forget the influence on all this question of the ingenious, the judicious, and the untiring G. P. A.

THE ECONOMY OF THE MODERN ENGINE ROOM.

II.—THE PROBLEM OF ENGINE SELECTION.

By Charles H. Davis and John S. Griggs, Jr.

ON account of the development of the steam motor from its primitive commercial form as a vertical beam engine for mine-pumping to the triple-expansion and quadruple-expansion high-pressure engines of the present day, with all the intermediate types still on the market, and for all of which remarkable claims are made, the difficulties which confront the would-be purchaser whose familiarity with the different types is frequently of the most elementary character are often very great, and his intelligent selection of a machine best adapted to his own peculiar needs is not usually forwarded by the strenuous representations made by the manufacturers or their agents, who pour in upon him until he almost believes that a high pressure multiple-expansion condensing steam plant, with coal costing ninety cents a ton, for a small plant, is a better investment than a single-cylinder engine running with moderate steam pressure. This article is intended to clear up some of these difficulties, and make the path of the purchaser a smoother one.

There are so many duties required of an engine, and so many different conditions to be met and overcome, in order to make it possible for the manufacturer to show a dividend at the end of the year, and also at the end of the tenth or twentieth year, that it must be evident at the outset that no one machine or type can satisfy all of these requirements. For purposes of comparison, then, we take the single cylinder, the compound or double cylinder, and the triple-expansion machine, and consider in detail the merits and advantages of each.

The question of steam consumption is one of the first to confront us; varying, as it does, so largely, it becomes one of the most important factors in the operation of an engine, and, therefore, in its selection.

Table No. I, showing the average amount of dry steam used per h.p. hour by the various types and under different conditions, is compiled from actual tests, made in most cases for the owner or manufacturer, to fulfil a guarantee, and therefore under conditions conforming more nearly to the ideal as to loads, steam pressures, etc., than is usually possible in the actual operation of a plant; hence the actual performance of any of these machines might naturally be expected to show a slightly greater consumption of steam and coal in daily or yearly operation. However, all having had similar advantages in the tests, it is possible to compare the results.

TABLE NO. I.

STEAM CONSUMPTION IN POUNDS PER HORSE POWER HOUR.

TYPE OF ENGINE.	STEADY LOAD.		Variable Load 50% to 125%		Extreme variations. Railway work, etc., 0% to 150%	
	Non-Con.	Con.	Non-Con.	Con.	Non-Con.	Con.
High Speed, Simple........	32	28	34	30	36	31
High Speed, Compound....	23	18	25	21	27	22½
Slow Speed, Simple..	25	21	28	23	31½	26½
Slow Speed, Compound....	20	15	22½	18	26	23
High Speed, Triple expansion	17½	13	20	16	..	..
Slow Speed, Triple expansion	14½	12½	17	15	..	..

In the operation of a steam plant there is a certain amount of flexibility in the expense account, it being possible to vary some of the items materially, while others are nearly fixed. The engine-room attendance for the different types of machines in stations of equal capacity will be about the same per h. p. per annum, though, of course, this can be reduced in large central stations with several units, by different methods, such as automatic lubrication and other labor-saving devices, just as fire-room attendance in extensive steam plants is cut down by mechanical stoking. The character and cost of the fuel available then, will determine the type of machine adapted to give the most economical results, taking into account the cost of the apparatus,—except in some special cases, as noted hereafter.

To show the vast difference resulting from the use of the extremes, and to enable the purchaser to see clearly what is often misunderstood, Table II has been prepared. The cost of coal varies so that it is only possible to take a few cases. Along the lakes, and in the vicinity of the mines, where freights are low, a dollar and a half per long ton is about the average; on the New England coast and in New York, where coal from the southern fields can be delivered without transshipment, it is about three dollars; and in the interior, far from the mines, with high freight rates, it may run from four to five dollars, or even higher. The evaporation of water per pound of fuel is not a fixed quantity either, by any means, as we have seen in earlier articles, but in plants put in at the present time at least ten pounds of feed water should be evaporated into steam for each pound of coal burned under the boilers. This can very probably be increased by some of the numerous forms of economical boiler settings, or by careful firing; so the manager who makes use of the following table can readily make a percentage deduction or increase for any particular rate. This table shows the cost of fuel per annum for a five-hundred-horse-power plant running ten hours a day three hundred days a year. This will hardly be considered a large plant in these days of larger things, yet is of sufficient size to cover a great many existing or proposed stations; deductions for larger or smaller units can be easily made. These costs are computed for factory plants from the steam consumption in Table I, with an allowance of seven per cent. for banking fires and getting up steam in the morning; for electric-railway or central-station work, where the run is longer and the time of idleness thereby shortened, this would be considerably less.

TABLE NO. II.

COST OF COAL PER ANNUM OF A 500 HORSE POWER ENGINE.

TYPE OF ENGINE.	Steady Load.					
	Non-Condensing.			Non-Condensing.		
Coal per ton	$1.50	$3.	$5.	$1.50	$3.	$5.
High Speed, Simple	3440.	6880.	11467.	3010.	6020.	10033.
High Speed, Compound	2473.	4945.	8242.	1935.	3870.	6450.
Slow Speed, Simple	2688.	5375.	8958.	2258.	4515.	7525.
Slow Speed, Compound	2150.	4300.	7167.	1613.	3225.	5375.
High Speed, Triple expan.	1879.	3758.	5263.	1397.	2793.	4656.
Slow Speed, Triple expan.	1559.	3117.	5197.	1344.	2688.	4479.
	Variable Load, 50% to 125%.					
	Non-Condensing.			Condensing.		
Coal per ton	$1.50	$3.	$5.	$1.50	$3.	$5.
High Speed, Simple	3655.	7310.	12183.	3225.	6450.	10750.
High Speed, Compound	2688.	5375.	8958.	2258.	4515.	7525.
Slow Speed, Simple	3010.	6020.	10033.	2473.	4945.	8242.
Slow Speed, Compound	2419.	4338.	8063.	1935.	3870.	6450.
High Speed, Triple expan.	2150.	4300.	7167.	1720.	3440.	5733.
Slow Speed, Triple expan.	1828.	3655.	6092.	1613.	3225.	5375.
	Extreme Variations, 0% to 150%.					
	Non Condensing.			Condensing.		
Coal per ton	$1.50	$3.	$5.	$1.50	$3.	$5.
High Speed, Simple	3870.	7540.	12900.	3333.	6666.	11008.
High Speed, Compound	2903.	5805.	9675.	2419.	4838.	8063.
Slow Speed, Simple	3386.	6772.	11188.	2849.	5697.	9496.
Slow Speed, Compound	2795.	5590.	9317.	2473.	4945.	8242.

The steam pressure calculated to give the best results with simple engines is from 80 to 100 pounds; for compounds, from 120 to 140 pounds; for triple-expansion, 160 to 180 pounds. Quadruple-expansion machines are used only in very large plants, usually when space is much restricted, and where it is possible to carry very high pressures. The best examples are found on the fast ocean liners, and a discussion of their merits hardly comes within the scope of this paper.

While the cost of coal is the principal item of operating expense, aside from the labor, the oil and waste used in the engine room frequently amounts to a large sum, and there can be no doubt that a great deal of this is absolutely wasted by the engineer in his endeavor to keep everything cool. Suitable oil receivers and filters reclaim a portion that goes into the oil cups, but much too large a proportion is never recovered. Engines which in their design have had some provision made for automatic lubrication are to be preferred for most classes of work, if too much has not been sacrificed in other details to gain this end. An arrangement which provides for an excess supply of oil on all running parts, to be returned to a tank or receptacle and used again and again, is probably the simplest and best. Most manufacturers now-a-days will guarantee oil consumption as well as steam economy, and their representatives can so instruct the operating engineer, when starting a plant, as to secure such results. A system such as is used by railway managers with their locomotive engineers could be used with profit in stationary-engineering practice. The oil used on a five-hundred-horse power engine in a year will vary in cost from one hundred or one hundred and fifty dollars for an automatically-lubricated simple engine to five hundred or even higher for a cross-compound condensing machine; if the engine room is kept clean, the amount of waste will be in proportion,—from ten to fifty dollars; this includes the cylinder oil as well as the engine oil. The internal friction of a machine, which must be deducted from the horse power shown by the indicator cards, is often much too large, and should always be considered in selecting a machine. Simple engines should run at friction load of not more than three to five per cent. of their rated capacity, and compounds at from eight to ten per cent. Friction is absolute loss, which should and can be greatly reduced; attention to this subject will repay the purchaser. The cost per horse power of simple high-speed belted engines from twenty-five to three hundred horse power ranges from twenty to ten dollars; when arranged for direct coupling to dynamos, the cost is increased from fifteen to twenty-five per cent. Slow-speed simple engines, one to five hundred horse power, cost from eighteen to eleven dollars. Compound high-speed, one to five hundred, cost from sixteen to nine dollars. Compound slow-speed machines, one hundred and fifty to one thousand horse power, vary from twenty-one to twelve dollars. Triple-expansion, from four hundred to two thousand, would be from twenty-three to ten dollars. It is evident, then, that the installation of an expensive Corliss compound condensing plant would not be warranted in a station where fuel is cheap, as the additional expense, when compared with a simple engine plant with its smaller foundations and greater simplicity, would probably balance the saving in fuel resulting from the compound machine, besides having the advantage of doing away with the somewhat complex arrangements of the latter rig.

The regulation in speed required of a machine, as determined by the character of the work to be done, will also influence the choice. In street-railway and rolling-mill work, where there are extreme and sudden fluctuations in the load, a considerable variation in speed, with proper precautions to prevent wreckage, is permissible, while in the more exacting service of cotton and silk mills, and electric lighting, where such variations would do serious harm to the product, a much more evenly running machine is demanded,—a demand which has developed the remarkably close governing devices now in use. There are cases in which large fluctuations in the load and close regulation are both required, as in buildings where it would often be desirable for electric elevators and lights to be run on the same circuit. This indicates the perfection which we hope to attain, and towards which very gratifying steps have been made; although complete success has not yet rewarded the efforts in this direction, its attainment is only a question of time. Generally speaking, poor regulation means lower economy in operation, and is to be avoided; and, where electric machinery is used, this may do serious damage to certain parts of the system. Short-stroke high-speed engines, on account of the greatly increased number of times per minute that steam is admitted to the cylinder, and the consequent shorter intervals during which the momentum of the revolving parts is expected to maintain the speed, usually give much closer regulation than the slower and longer-stroke machines, and are, therefore, to be preferred to the latter in special cases. Owing to the slower recovery in long-stroke machines, the fly wheel has to become the receiver for the energy, giving out towards the latter end of the stroke the excess absorbed during admission of steam, which accounts for the variation from end to end of the stroke so noticeable in large horizontal slow-running blowing engines, and others of that kind. It would be possible, of course, even with this type of machine, to get almost perfect uniformity of speed by the use of enormously heavy fly wheels, but it is not feasible commercially. This brings us naturally to the question of fly wheel, and the frequent accidents due to rupture thereof; and in this connection it must be remarked at once that it is nothing against the wheel that it breaks, for its failure to hang together is almost always due to the failure in some other part of the mechanism, and to the fact that the tensile strength of cast iron has a pretty well known limit, beyond which centrifugal force will surely go, if allowed. Wheels should and can be designed for extreme variations of speed, but they can all be broken by systematic carelessness. All engines of this class are provided with automatic devices to prevent the "running away" of the machine, but, when the governor is blocked up to allow for heavy loads, the results can be predicted with great certainty.

While the foregoing may assist the purchaser in his quest generally, there are particular cases and conditions which outweigh questions of economy,—for instance, the very extensive use of steam engines for isolated electric plants in modern hotels, apartment-houses, and high office-buildings. In these structures one of the first considerations is the space which can be given to the electric plant, and it is usually all too small, prohibiting the use of belted apparatus, even if the combined efficiency was as high as that of the direct-coupled engines and dynamos now used almost exclusively. In such plants, where the exhaust steam is almost universally used for heating the building, or for domestic purposes, the best machine to use is the single-cylinder one; for the pressure required for the heating system often runs higher than five pounds, and this back pressure on the low-pressure cylinder would nullify all the good effects that could be obtained from compounding under favorable circumstances. This throws most of the load upon the high-pressure cylinder, which would then cut off much beyond its economical point, and probably make a poorer steam showing than a simple machine of the same capacity. In places where the load on the machine is a variable one, as for elevator service and electric railways, where the maximum load is frequently, for a few seconds at a time, double the average load, the mistake has been made of putting in engines altogether too large for the work. This has happened on account of the danger of straining the machine, if its cylinders and frame are designed for taking care of the *average* load economically, as the frame is not heavy enough to withstand the severe shocks.

The result is that the larger machines installed are running a great deal of the time at a most extravagant steam consumption. This can be overcome, and much better results obtained, by using the large frame as before and putting on this frame cylinders of a size to develop the average load at the most economical point of cut-off; their regular operation will then be as near as it is possible to get to the theoretical, and, by means of the automatic governor, steam will be admitted for the maximum power when required. The smaller cylinders render the first cost slightly less than the standard, and the cost of operation is also greatly reduced. How great this difference is is shown by a test of a compound engine, which, with cylinders more than twice too large for the average work, required twenty-five pounds of steam per horse-power hour, and, when loaded to its capacity under favorable conditions, showed an economy of sixteen pounds per horse-power hour.

There are several other cases besides that of the office-building where the choice of a proper machine cannot be made absolutely by consulting the table of fuel costs. Where a manufacturing plant, on account of the nature of the product and the raw materials used, has to be located in the wilderness, far from the base of supplies, and often long distant from even ordinary machine-shop assistance, simplicity of construction is absolutely demanded, even at the expense of some other things. The shutting down of the engine for a few days, throwing the whole working force out for that time, while waiting for some small repair part to be supplied from the factory, would more than neutralize the economy attained by the complex machine. This chance of accident is, of course, increased in the machine having the complicated mechanism, which complication would be entirely warranted in large manufacturing centers. In this connection the question of the condenser may properly be considered, as it is an important adjunct to the economical success of many plants. It is almost unnecessary to say that the condenser should always be so connected to the exhaust from the engine that the engine can be used independently, exhausting into the atmosphere when repairs are necessary to any part of the condensing apparatus, or when the supply of condensing water gives out. At such times the power of the plant, if it be properly designed, can be brought up to its "condensing rating" by an increased steam pressure, or, if this be impossible, the governor will take care of the increased power required from the engine itself, cutting off the steam later in the stroke.

The use of the condenser is to be recommended in large plants pretty generally, and usually shows an improvement in the coal bills, when compared with the same plant without the condenser, of from ten to twenty per cent. In cases where a sufficient supply of water for condensing purposes is not available, some arrangement which provides for the cooling of the heated water of condensation after leaving the condenser pump, whereby the same water can be used again and again, has been used with advantage, although its continued efficiency has yet to be proven. Jet condensers being used for this arrangement, the addition of the condensed steam from the engine to the condensing water in circulation through the system is sufficient to maintain the amount necessary against all ordinary leakage, entailing no extra expense for water-supply. An "air condenser," for the double purpose of reducing the back pressure in the heating system of a building and at the same time furnishing hot air for indirect heating, is used in some places with success at the tail-end of the heating circuit.

The proper ratio between the cylinders of a compound engine has been the subject of much discussion, but it is now pretty generally agreed that, when running condensing, the best results are secured with a ratio of 1 to 3½ or 4, and on very large units even as high as 1 to 4½; when a machine is to be used non-condensing, the ratio should be somewhat smaller, ranging between 1 to 2½ and 1 to 3½, increasing with the size of the machine; where an engine is to be operated with the condenser a portion of the time only, a ratio of about 1 to 3½ will give best results. Similarly, the ratio for triple-expansion machines between the high- and low-pressure cylinders, when condensing, should be between 1 to 7 and 1 to 8; when non-condensing, from 1 to 4½ and 1 to 5½. The form of compound used, whether cross or tandem, depends somewhat on how the power-house has been designed. Other things being equal, the tandem recommends itself on account of smaller floor space, simplicity of construction, only one set of reciprocating parts, smaller friction loss, and lower first cost. The saving in engine-room area reduces the investment for real estate and power-house. Better balance can be obtained in the cross compound, due to the cranks being set 180 degrees apart. It is also possible, when one side of the cross compound is disabled, to disconnect, and run the other half at reduced load.

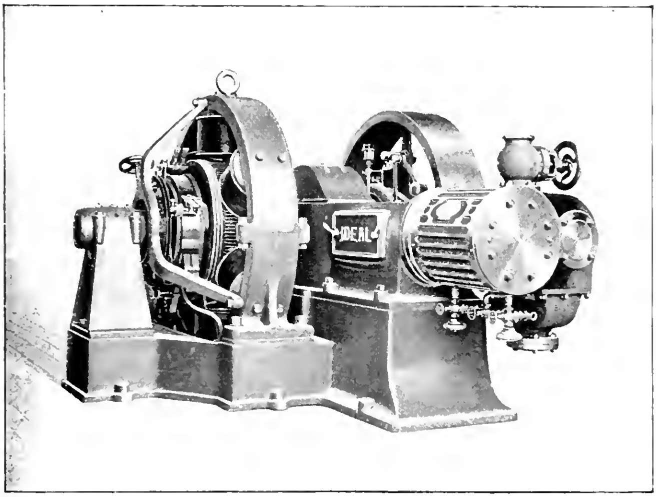
Other points to be considered are the general safety appliances for the regulation and operation of the machine, and chief among these should be considered the governor, which does not receive half the care and attention which its important position demands. A thorough inspection of the governor at regular intervals should be made, for the same reason that indicator cards are taken,—to insure the continued economical operation of the plant. One of the most frequent causes of disaster to an engine is the presence of entrained water in the steam as it comes to the throttle, and, where this is at all likely to occur, separators should always be used, and, when used, must be as near the engine as possible. Water in the cylinder, either due to priming in the boiler or cylinder condensation, is apt to cause trouble, and some efficient form of cylinder relief is as important as the safety-valve on a boiler, and must be of such character that its operation is certain, with ample area, and so arranged that it can be renewed, in case of an accident, when no other damage has been done, without stopping the machine and at slight expense. Proper arrangement of drip piping, check valves, and exhaust, to prevent the drawing in of water when the machine is being shut down, should also be made, but the details can hardly be considered here.

Whether vertical or horizontal engines should be used in any particular case, aside from the question of floor-space, usually depends on the personal inclination of the purchaser; there are certain advantages in each form. Considered mechanically, the vertical machine, with its reciprocating parts all supported by the brasses and pins where adjustment for wear can readily be made, and provided for in the design, has evident advantages over the horizontal, in which wear takes place inside the cylinder, both on piston and cylinder walls. With proper lubrication, however, this wear is very slight, and in the horizontal machine we have greater accessibility of the working parts for examination and removal, in case of necessary repairs. In running vertical machines, in places where quiet running is essential, it is impossible to get symmetrical indicator cards from both sides of the piston on account of the weight of the moving parts, which add to the pressure in the downward stroke, and detract from it in the upward stroke. This means a slightly increased operative cost, owing to the imperfect steam distribution. Increased head room is necessary, both for the machine and the space required to remove pistons and rods. Single-acting vertical machines with double cylinders, of which the Westinghouse and Willans are very good examples, have been designed to overcome some of these disadvantages, and are used with great success in numerous cases. European practice regarding vertical engines is very different from that with which we are familiar in this country, as the horizontal type is almost unknown, the other style being used for mill work and general power purposes everywhere; this can probably be traced back to marine practice. There can be no doubt of the fact that in the ocean steamship we have the best example of economical steam development and utilization, which has resulted, of course, from the necessities of the case, where coal consumption is all important for the double reason of first cost and limited storage room; of course, the ordinary stationary steam plant is not to be compared in size with the marine plant, but there are some lessons to be learned from the latter, and one of the most important is the influence of high pressure on the economy. Locomotive engineering points in the same direction. Recent tests made by the Chicago & Northwest Railroad on fast passenger locomotives, carrying a pressure of from 180 to 190 pounds, with the ordinary slide valve, show an economy of 24 pounds of steam per horse-power hour. This is at first rather surprising, accustomed as we are to consider the locomotive as an extravagant machine, but, looking at the subject thermodynamically, remembering that it is really as a heat engine that the steam engine must be considered, and that the range of temperature gives it its efficiency, it is not so great a cause for astonishment. The general tendency of the times is towards higher pressure, undoubtedly, and, if it can be used to advantage with safety under conditions giving strains as severe as those to which a locomotive is subjected, we are certainly warranted in going as far, at least, in stationary practice, under much more favorable conditions. We believe that the next ten years will see a still greater advance in this direction.

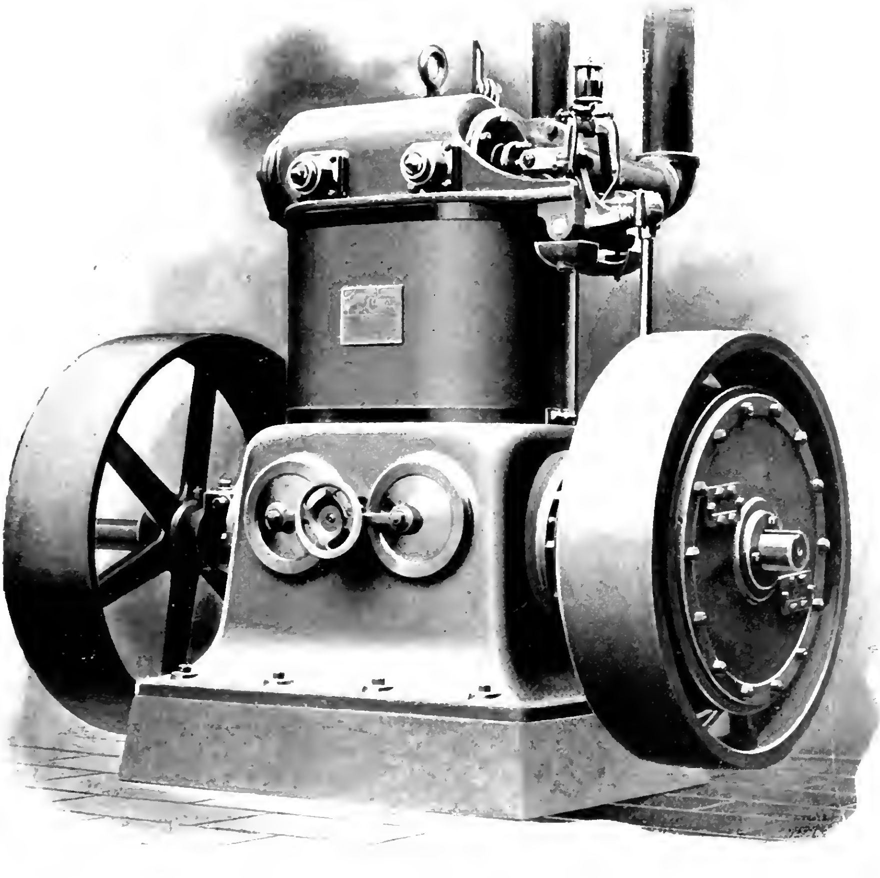
After the purchase of the engine, another very important factor in its successful operation is the foundation on which it rests. This should always be the subject of correspondence with the engine manufacturer, as his experience in this line with his own machine enables him to suggest what will give the best results ; and, where possible, the foundation should be put in and fully guaranteed by the engine-builder. The purchaser will then know in advance what the machine will cost, complete ; a "cheap" engine often requires a much heavier foundation than one costing more in itself. Further, the engine should always be assembled and erected on the foundations by the builder. A clause in the contract requiring the manufacturer to operate the machine for a short period protects both parties, and gives the owner's engineer an opportunity to gain information as to the proper care of the engine from those most familiar with its details, and therefore best able to instruct. Particular attention should be given to the "balance" of a machine when running at normal speed. Perfect balance means less wear and tear on all the parts, and longer life. Absence of vibration secured by enormously heavy foundations to which the engine is rigidly bolted is to be avoided ; the strains are present, with every reversal of motion, even if hidden, and will tell in the end. All of the better class of high-speed engines can be run without fastening to the foundations, and are usually so run and tested before acceptance, and then bolted down.

In electrical work a large proportion of the engines now-a-days installed are of the direct-coupled type. The principal advantages of such an arrangement are the great saving in space, which in a large station materially reduces the size and cost of the power-house ; the reduction of the losses by friction in belting and counter-shafting ; the possibility of running slower-speed generators of higher efficiency ; the better appearance. In engines for this class of work the shaft should be a solid steel forging to which the dynamo armature is keyed direct. The use of a coupling is quite unnecessary, if the shaft and working parts are properly proportioned to withstand the strains that may come even with short circuiting, and, where space is so important a consideration, it seems useless to add to it when nothing is gained. The cut of the single-cylinder direct-coupled Ideal engine shows one of the standard machines used for isolated lighting and power, while the Reynolds-Corliss machine is a familiar type in large electric-railway stations.

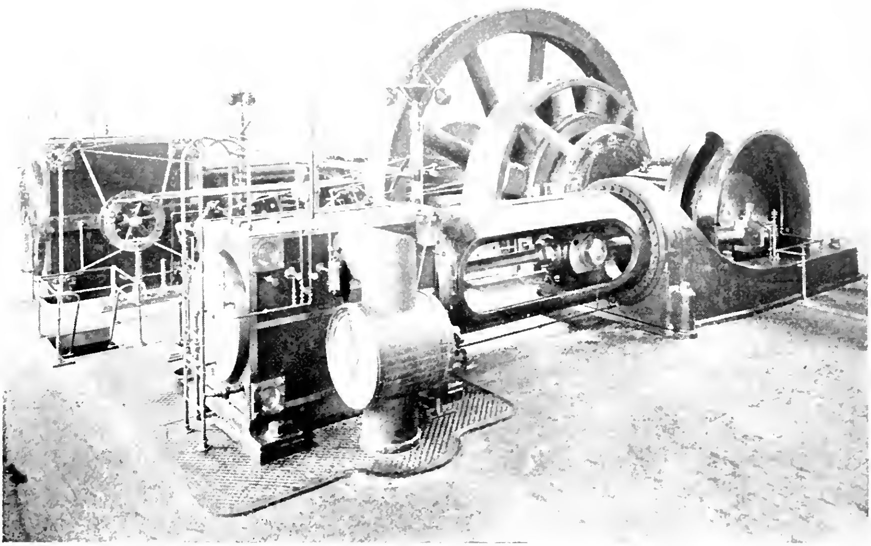
Where belting is necessary, and the conditions allow, the use of several small units, advantageously located through the works, will



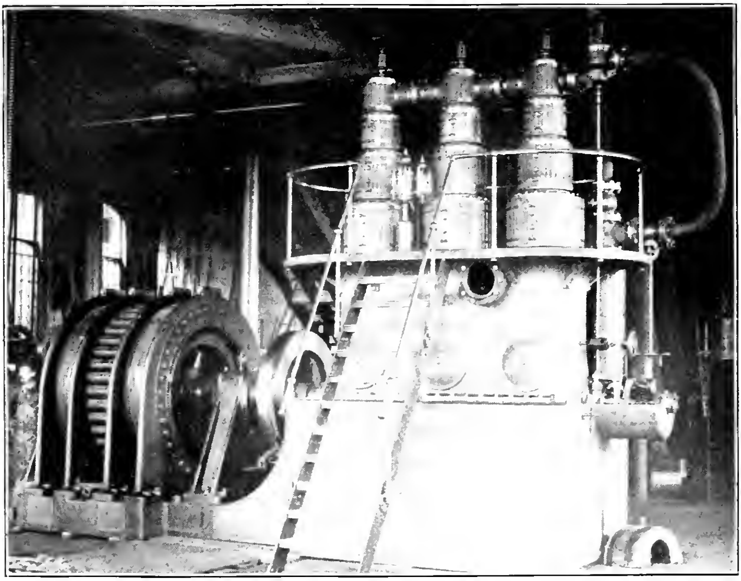
THE IDEAL—A SIMPLE DIRECT-CONNECTED ENGINE.



THE WESTINGHOUSE COMPOUND ENGINE.



THE REYNOLDS-CORLISS ENGINE. EDW. P. ALLIS CO.

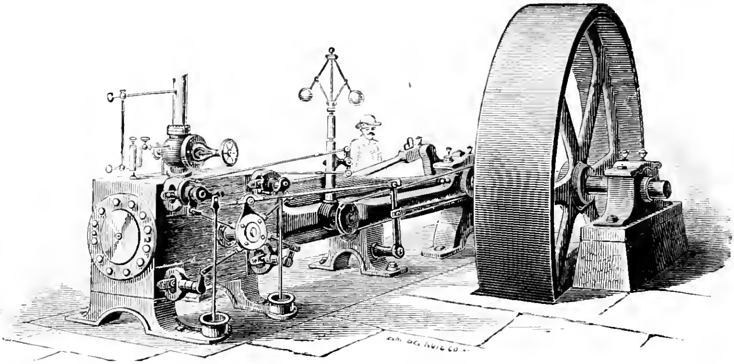


THE WILLANS TRIPLE-EXPANSION ENGINE.

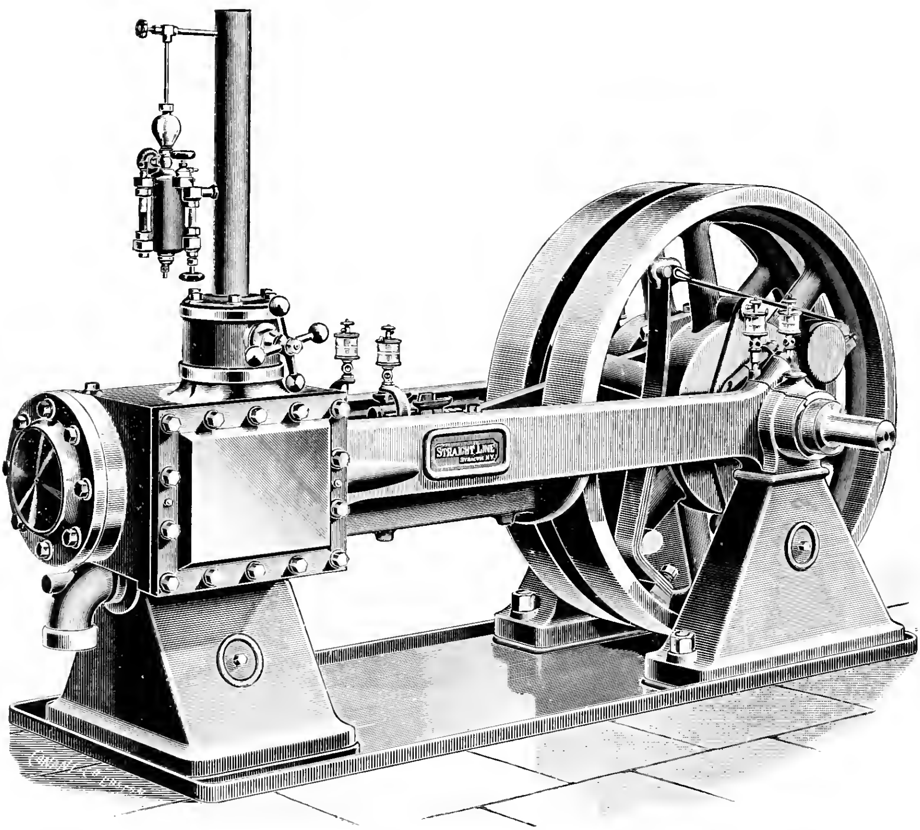
give better results than one large machine. By following this plan long lines of main and counter-shafting and gearing can be dispensed with, and the different departments can be shut down at will, without interfering with the rest of the plant. In the old way, with a central source of power, more than half of the indicated power of the engine was often lost in friction; this power, while originally developed at great economy, if considered at the engine alone without regard to work done, was really very expensive. One of the single-cylinder machines that has been very largely used for this class of work is the Straight-Line shown in the cut. There are cases when it is not possible or advisable to so divide the units, and where an economical prime mover is desired, which would call for a single slow-running machine. The Watts-Campbell is a good representative of this class, and its general features are shown in the illustration.

Essential to the general design of the machine are the proper proportions of the pins and shaft to the cylinders. The development of a class of work giving severe and suddenly-applied loads to a machine has brought a general revision of these details in the design of present engines as compared with those generally in use twenty years ago, and the running parts are now considerably heavier. Special attention should be paid to this in looking over specifications; while no rules or formulae can be given, it may be said that, of several engines with equal cylinders having different-sized shafts, and crank and cross-head pins, the one in which these are largest is usually to be preferred. None of them are too large. So, too, the general character of the workmanship and material entering into the machine must be noted; a well-designed machine, if poorly built, is as poor an investment as a "cheap" article of any kind. The exterior finish, while often very noticeable and pleasing to the eye when well done, is not as important as care and attention in the fitting-up of the running parts. Better a dull, black machine with rough nuts, that will run steadily and economically with the minimum of repairs, than a highly-polished engine stopped frequently for adjustments.

Although not included in the steam line, this subject would hardly be complete without some reference to the gas engine. Up to the present time the gas engine has been used principally where small power was needed, not warranting the expense of a steam plant and engineer, where close regulation in speed was not essential, and where an engine would run with little attention. But there are a few machines in this country in electric-lighting service, as large as 100 horse power, which have been running for two or three years very successfully. They are still in rather an elementary stage, compared with steam-engine practice, but their perfection is greatly to be desired, as



THE WATTS-CAMPBELL—A SIMPLE CORLISS ENGINE.



THE STRAIGHT-LINE ENGINE.

their use removes one complete link from the thermodynamic chain, cutting out, as it does, the boiler, and burning the fuel directly in its cylinders. Careful tests show an indicated horse-power hour with a fuel consumption of less than 1¼ pounds, which is equal to about the best that is attained by the use of the triple-expansion steam engines. Further development of the gas engine, tending to simplify its present complex method of mixing air and gas, and the governing devices, will be watched with great interest by the engineering profession.

Great caution should be exercised in accepting extravagant guarantees on new machines. The results to be expected from old and tried designs are well known, and it is extremely improbable that any new features can be introduced which will make any startling changes in present conditions; but manufacturers are often willing to make unusual promises on new machinery, which they had better be allowed to try on some one else.

Recapitulating briefly, we see that high-speed engines should be used in all cases where the power required is small and the total cost of fuel relatively low; for direct-connected electric-lighting work; and in large works where a distribution of the units can be made profitably. Compound engines of this type are to be selected for somewhat larger work, for small electric roads, and central-station or small municipal electric plants. Simple slow-speed engines will run to greatest advantage in factory service where the loads are moderately steady and not large enough to warrant compounding, and where very close speed regulation is not essential. Compounds should be used as soon as the size shows a sufficient economy, particularly if water is available for condensing. Slow-speed compounds should also be adopted for large electric railroads, where the percentage fluctuation is not as great as on lines having only a few cars. Triple-expansion machines should be chosen only when the units are large and the loads are pretty steady, or where the cost of fuel is so high as to make it necessary to take every step to reduce the coal bills. This summary can be only general, as other conditions will often make the choice a difficult one, and render the expert advice of an engineer necessary, as Dr. Emery has pointed out in his article on boilers.

In conclusion, there is one thing necessary to make the steam engine efficient after having secured the type best suited to the owner's particular purpose, and that is intelligent operation. Given these two,—a proper engine and a careful engineer,—the owner can rely on getting the best results, and give his attention to other details of his business.

AN ARRAIGNMENT OF AMERICAN CITY ARCHITECTURE.

By E. C. Gardner.

IN these closing years of the nineteenth century we are doubtless the richest, most versatile, most competent, and most enterprising people on the face of the earth. Perhaps this is unfortunate: perhaps we are too rich, too enterprising, too "hustling." Perhaps the inevitable result of this swift accumulation and vigorous growth is that we do many things that were better left undone, and often fail to make good use of our too rapidly acquired wealth. To be accused of an inordinate desire to "make" money, with not excessive scruples as to how it is made, and scant consideration, amounting almost to contempt, for the intellectual and moral qualities likely to be sacrificed in this pursuit of mammon, is by no means the most serious charge that can be brought against us. Neither is the reminder that a fool and his money are soon parted the hardest thing that one who has squandered his inheritance has to bear. When his money is worse than wasted; when he has not simply nothing to show for it, but something worse than nothing, a permanent record of his own folly, the tablet whereon it is written placed where it can be seen and read of all men,—his condition is enough to make the angels wonder and posterity weep.

Yet it is undoubtedly true that the charge of reckless folly can be made with justice against the majority of those who have been able to record their ignorance of architecture in brick and stone and iron,—that is, those who are responsible for the buildings along the streets of our cities. It is quite within bounds to say that nine-tenths of the structures devoted to commercial uses, three-fourths of our municipal and public buildings, and at least one half of our churches are, as regards their so-called architectural qualities, permanent monuments of ignorance, vulgarity, and incapacity. If all this is really true,—and it will at least be difficult to show that it is not,—it is surely time to consider how the enormous waste involved can be arrested.

If architectural excellence were a mere matter of taste concerning which there is no room for dispute, it would be idle to discuss the subject. It is not; it is a matter of knowledge, of well-trained judgment, of clear esthetic perception and practical skill. No sensible man needs to be advised that his opinions on matters with which he is unfamiliar are of little value. Why should he, when he is ready to erect a conspicuous building on a public street, insist that his taste in architecture is correct and worthy to be followed? He has never made a study of the art; he is not even familiar with the best work that has been done, and is too ignorant of the principles that underlie all good work—probably never suspected there were any—to distinguish the good from the bad. How can such a man dare to erect on a public street a building which, though it please himself, defies the criticism and scorns the approval of those who alone are capable of judging it correctly? Many a good man and true would rather hear his wife and

CHAMBERS STREET, LOOKING WEST FROM BROADWAY, NEW YORK.

A CHICAGO SKY-SCRAPER.

children sing nursery songs to the accompaniment of an old tinkling piano than listen to the grandest harmonies of the great masters of musical art; if such were not his preference, at least for a part of the time, he would be an unsatisfactory husband and father. But, if he were allowed to select the music to be played in the public square, like the secret melody of Memnon's statue, every morning at sunrise through coming generations, would he trust his own unmitigated ignorance? Not unless he was one of those who rush in where angels fear to tread. Architecture, in apt and graceful figure, has been called frozen music. A more accurate comparison for the most of what we call our street architecture would be a dull, discordant, senseless noise, devoid of harmony or rhythm.

It is an extremely rare thing to find a business block—one of the multitudes on which the average business man inscribes his name in lasting bronze or granite, and which he hopes will be a source of family pride as well as of substantial income to his great-grandchildren—that, by reason of its external architecture, can be called a thing of beauty and a joy forever. We seldom find a building to the "making over" of which any objection is made on the ground that a change will injure its appearance (the Bulfinch front is the one conspicuous

ST. JAMES STREET, MONTREAL.

LOWER BROADWAY, NEW YORK, LOOKING NORTH.

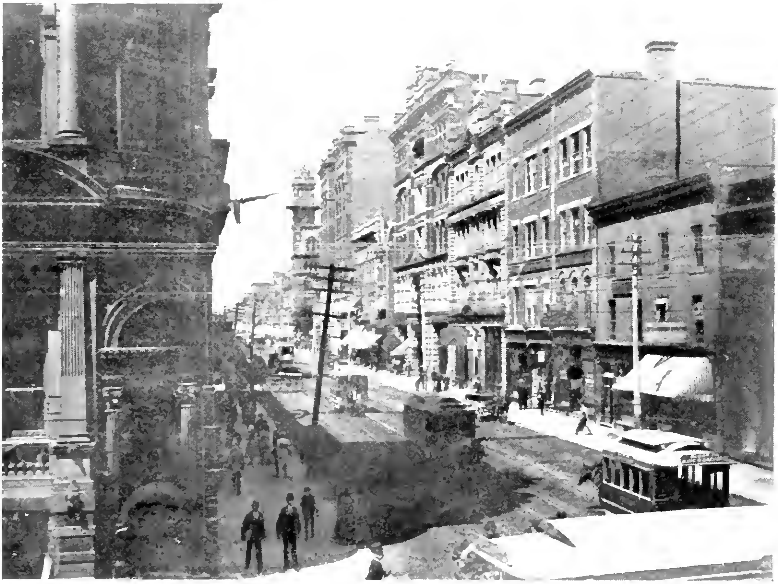
instance to the contrary, and there sentiment comes in for a share of the motive); we seldom find a building which an artist (excluding photographers) would for a moment think of introducing into a picture, even as a subordinate detail,—seldom one before which an intelligent company of sight-seers would involuntarily pause in order to admire the dignity of its form and the original beauty of its decoration. There are buildings enough that bear some burden of carved stone or stamped copper, some terra-cotta modeling or colored glass, which one who has never studied stone carving, modeling in clay or metal, or "art glass decoration," will gaze upon in round-eyed and open-mouthed amazement. He is sure it must be wonderful, because it surpasses anything he has ever seen before. True, it may surpass the rest in ugliness; but how should he know in which direction to look for merit? In truth, he knows just as much about it as he would of a book written in an unknown language. He may see that the paper of the book is good, the type clear, and the binding strong.

A CHICAGO CORNER.

but, as for the real book, it may contain the wisdom of the ages, or it may be a collection of all things commonplace or vicious.

Even the most thorough education will not make all men architects, artists, or musicians. There are those who will never in this world be able to distinguish one tune from another; others who are hopelessly color-blind; still others who appear to be form-blind—to whom a line of beauty is an unknown object—who have apparently no

A MINNEAPOLIS EXAMPLE OF THE HIGH BUILDING.



LOOKING WEST ON KING STREET, TORONTO.

VIA NAZZIONALE, ROME.

perception of intrinsic grace, no standard of refinement and elegance but familiarity,—that is, fashion. It is a blessed thing for humanity that the face of every mother is beautiful to her children, however it may seem to others. It is a deplorable thing for art that most men can see good only in that which is familiar, especially if it happens to belong to them. The most grotesque shapes, the most inharmonious combinations of color, are honestly thought to be beautiful and "becoming," if only they are in vogue. For this reason, and because there is so much more of bad than of good in architecture, it cannot be expected that the good will be admired or appreciated. Absolute utilitarianism, an utter absence of all attempts at architectural effect (except in the rare cases where architectural considerations are paramount and the best can be achieved), would be infinitely better than the halting, blundering, ignorant productions that are neither good architecture, good engineering, or good sense. A Florentine once said to me, with real Italian enthusiasm: "I love the houses along the streets and their dear, familiar faces. When I go out for a morning walk, they seem to bow in kindly recognition and return my greeting as if they were really glad to see me." It would require a powerful imagination to fancy the fearfully and wonderfully designed façades in any American city possessing either the ability or the disposition to do anything but stupidly stare friends and foes out of countenance and complacently flaunt their own ugliness.

I know it is one thing to say these disagreeable things about every-day architecture, and quite another to make their truth apparent, be-

HIGH STREET, OXFORD, ENGLAND.

A PART OF FIFTH AVENUE, NEW YORK.

cause esthetic perception is a faculty of slow growth, and those who lack it most are usually the most abundantly satisfied with their own opinions. As an experimental test, compare half-a-dozen photographs of the average buildings along the principal streets of any of our cities with the same number of similar photographs of the best buildings in the world, architecturally considered,—buildings of similar size and intended for similar uses. There would be difference of opinion as to which are the best buildings in the world, as there would be concerning the greatest poets, musicians, or artists, but there will be no difficulty in finding work of whose intrinsic excellence there is no question. He who should be incapable of perceiving the superiority of the good in such a comparison (which would be no crime, of course ; only a misfortune) would probably consider the hammering of an ill-bred child on the helpless keys of a piano just as agreeable as the magnificent chords of Handel's Largo.

It is useless to compare photographs or other pictures with actual buildings, because none but those who are familiar with the evolution of architectural design can form a correct idea of the appearance of a real building from a pictorial representation of it. (This common incapacity, by the way, gives opportunity for one of the most successful "tricks of the trade," especially in that part of it which is connected with competitions,—that is, the employment of a skilful artist to prepare a colored perspective of the proposed edifice, and by that means captivate the committee, whose knowledge of good architectural design seldom goes beyond a juvenile admiration for a "pretty picture." This idealizing operation accounts for many disappointing decisions of building committees.) That photographs should be compared with photographs and line drawings with line drawings, and that perspectives, for purposes of comparison and competition, should be ruled out altogether, is a condition so obviously necessary for a just comparison that it would not need to be mentioned if it were not so constantly violated.

Another helpful experiment would be to find the best work in the city, and compare it studiously with the poor work around it. In this case, however, the good work is at a disadvantage for the reason above intimated; its rarity prevents recognition of its merit. Its message is virtually in an unknown tongue. And yet this is the only way in which popular education in this direction is achieved; slowly,—oh, how slowly!—involuntarily, and unconsciously.

Among the more conspicuous causes of the public obtuseness concerning architecture is the attitude, supposed to be necessary, of the local papers, which, in spite of so many protests to the contrary, do, to a large extent, direct the opinions of their readers in all matters that are outside of their personal interest or study. It is sufficiently

A CORNER IN PHILADELPHIA.

A GLIMPSE OF THE VIENNA STREETS.

unfortunate when the "art," "musical," or "literary" editor of a paper read by thousands who have no other opportunity for acquiring intelligent opinions informs his readers that worthless books, concerts, and pictures are worthy of the highest admiration, remarkable examples of our increasing culture and civilization. Yet the music may be forgotten in a week, the book may be laid away on the library shelves, and the picture left to blush unseen in some rarely-visited corner of the gallery. But a grievous and incurable harm is done when an esteemed and public-spirited fellow-citizen has the audacity to set up a seventeen-story block in defiance of physical, architectural, and moral law, and the public are assured, as by one having authority, that we have at last in our beautiful city "a monument of artistic grace" of which we ought to be proud. In similar false and fulsome phrase every new dwelling-house, whatever monstrous shape it may assume, however crude in color and form, however childish in composition, however grotesque and barbarous in detail, is described as a charming and unique addition to our varied and interesting domestic architecture, when there is not a visible quality about it that can be called architecture, unless the word is applicable to millinery, chidren's toys, and feminine bicycle costumes. Caprice is not architecture; exaggeration of necessary or useful features to the verge of absurdity is not architecture; novelty for the sake of novelty is not architecture; nor—let this be written large—do a few classic details, though copied directly from Vignola and indiscriminately applied to the outside of a building, make a "colonial" mansion of a broken-backed barn.

But to return to the papers and the lies they tell in the guise of architectural comment and criticism. Anything like public comprehension of good architecture seems hopeless while these shallow and essentially false comments are the only instruction ever offered to the people responsible for the style of our buildings. It would be obviously impracticable for an intelligent editor—and the more intelligent he is, the more difficult it would be—to say just what he thought of the buildings of his neighbors; but it would seem to be possible for

BOULEVARD MONTMARTRE, PARIS.

him either to keep still, or to employ a competent critic to describe the merits of any building that possessed merits, and honestly commend the owner and architect, kindly ignoring what could not be wisely approved. Even this silence, which would soon be understood as tacit disapproval, might in the rough and ready regions cost an occasional subscriber, but it ought rather to strengthen a daily paper in communities where the arts are supposed to be fostered and appreciated. I refer to the daily papers in this connection because those who really desire to be well-informed have no difficulty in finding such instructions and information as they need in the various ably-conducted technical journals. But it is not those who desire to be instructed for whom instruction must be provided, but for the lost sheep

HOLBORN VIADUCT, LONDON.

who are unaware of their own ignorance, and to whom instruction must be given sugar-coated and in such form as to soothe rather than wound their self-complacency.

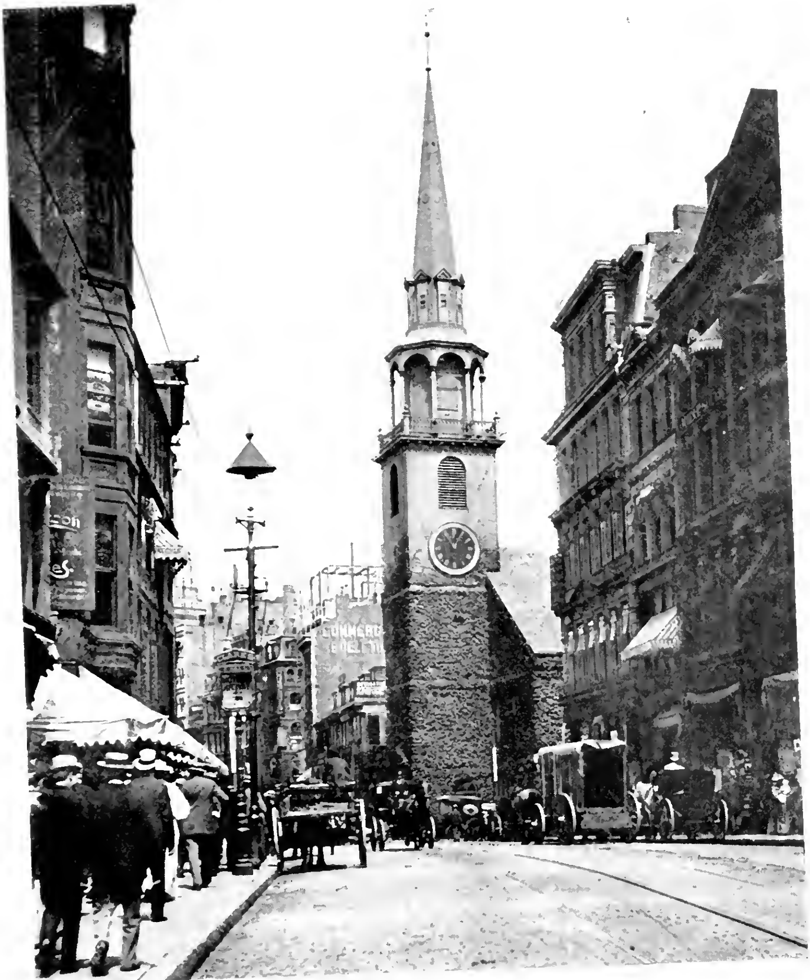
Aside from the objection to frank criticism that it might operate to injure the commercial value of private property, there is, in the

THE MANSION HOUSE AND CHEAPSIDE, LONDON.

case of religious and benevolent institutions, a sentiment that the purpose of the building lifts it above the possibility of adverse comment, even as to its outward form. Of course the most frequent illustrations of this are found in the nondescript churches which might easily be mistaken for country club-houses or extravagant stables. Shall we ever outgrow the notion that a shingled buttress gives an ecclesiastical expression to a wooden building that would be stronger and better without it? At best it is but a caricature, and caricature is the grossest form of irreverence. But wooden churches are not the only ones that stand on the wrong side of the narrow chasm between the sublime and the ridiculous.

LITTLE CHAMPLAIN STREET, QUEBEC.

Another common cause of the failure of our every-day architecture is the endeavor to combine incongruous uses in one building. The attempt to place Masonic Temples or Young Men's Christian Association rooms on the top of a commercial building and give to each its proper expression without transgressing all the known laws of construction and common sense cannot possibly result in anything else than an architectural hodge-podge. There should be as distinct a difference between a commercial building and one devoted to moral, religious, or philanthropic purposes as between a cooking-stove and a bedstead. Good architecture is not possible on any



WASHINGTON STREET AND OLD SOUTH CHURCH, BOSTON.

other basis. Far better to resign all attempts at architectural quality and make the building absolutely utilitarian.

The controlling influence of Mammon is perhaps as disastrous to all forms of art as it is to religion, and, while it is doubtless true that popular ignorance is more largely responsible for our architectural sins than professional incapacity, it is true in both cases that the mercenary influence is most disastrous. The architect must cater to the depraved taste of his client or lose the commission, and the owner must build something that suits the depraved taste of the times, or he can neither command the highest rents or sell at the highest current price. Neither can afford to wait for the verdict of an enlightened posterity. Even admitting that all well-educated architects "in good and regular standing" are free from mercenary considerations, the important fact remains that a large portion of the "architecture" of the country is "done" by men who are *not* in good and regular standing,—who are simply manufacturers and dealers. They buy, borrow, steal, and, by the employment of more or less competent draughtsmen, manufacture, plans to suit what appears to be the popular demand. They have but one aim,—to sell their goods at a profit; but one standard of excellence,—immediate popular approval.

THE CAÑONS OF THE CANADIAN PACIFIC.

After all the foregoing condemnation, it is no paradox to say that, in the class of buildings referred to, we probably have some of the best modern architecture in the world, and in our great cities the buildings of the principal thoroughfares would appear to disprove the proportion of good and bad above insisted upon. It is also undoubtedly true that the best work is rarely found in any except the very large cities. Even in those, if the whole city (including the parts that are rarely familiar to any except the residents) is taken into the account as it should be, the ratio would hardly be changed. To say that there is nothing attractive in the appearance of very many of the

THE CAÑONS OF BROAD STREET, NEW YORK.

business thoroughfares in our cities large and small is quite another thing. In fact, the variety of color and form, of light and shade, and the life that animates them make nearly all streets, seen in perspective, attractive and picturesque. All the more so because the details of each building cannot be distinguished. The beauty of the street depends upon almost the same qualities that give charm to a deep rock-cutting for a railroad, and still greater to the narrow gorge or cañon of a river.

The high vertical walls, the broken surfaces of various colors, the play of light and shade, the combination of details in themselves unmeaning, all taken together and seen as a single picture, are full of interest and a kind of beauty. But a closer inspection, made face to face with any portion of the wall, reveals in the street crude, coarse, ungainly forms, without beauty of their own or harmony with their surroundings. While it is idle to compare any beauty of a work of art with natural beauty, nothing deserves the name of art which does not indicate refinement in its conception and trained skill in its execution.

We have a right to demand that the buildings along our streets shall be a succession of beautiful pictures, and, while there may be plausible, perhaps imperative, reasons for complete plainness, absolute barrenness of architectural effect, there is no excuse for positive ugliness.

GAS VERSUS ELECTRICITY FOR POWER TRANSMISSION.

By Nelson W. Perry.

THE development of electricity as a commercial factor has probably done more for engineering science indirectly than it has directly, great as have been the direct benefits. When we realize that in 1881 (when the Pearl street Edison Central station was first started), after the steam engine had received the best efforts of engineering science for scores of years, there was still no steam engine in the market perfect enough to give satisfactory performance in this new and exacting service, and that to-day there are scores of makes of engines that very fairly meet these demands, we see what the commercial development of electricity has done for the steam engine.

But it is rather of engineering science in the abstract that we speak. The mechanical and the civil engineer deal with forces of which they may have full knowledge, but the effect of these forces, when acting through the materials and under the conditions with which they have to deal, are not amenable to exact calculation. For instance, if they would prognosticate the result of the transmission of energy by means of fluids, they would assume as a basis a perfect fluid, and then modify the results by empirical factors known to be approximately correct only under special conditions, all of which can never be exactly known or fulfilled. The electrical engineer deals with an assumed perfect fluid, and needs no factors to bring his calculations within allowable limits of error. He therefore attacks a problem with more confidence than does the hydraulic engineer, for instance, and perhaps it is this very confidence in his ability to forecast results with certainty that has led him to neglect other engineering branches, and to believe that they cannot assist him in his work.

But in this scientific, utilitarian age we must not overlook any agency, however humble, that may assist in accomplishing our ends.

Gas engineering is an old profession as compared with electrical engineering, and it is not unreasonable to suppose that electrical engineering can profit by its experience. In fact, our present methods of electrical distribution are almost exact copies of practice long since recognized by the gas engineer, who, moreover, has solved one problem which we, as electrical engineers, have still to solve,—*viz.*, the cheap and efficient storage of our energy.

We have the storage battery, to be sure, which is getting cheaper and more efficient every year, but it does not store the energy as does the gas-holder,—ready to be called upon at any time, and to respond equally efficiently to any rate of demand. Nor is it the ultimate solution, although, as will be shown, it is one of the most efficient methods known.

But the virtues and elasticity of the electrical system and the great simplification which it brings to engineering problems have blinded its votaries to the virtues of other methods of transmission.

To such an extent is this true that we find engineers of prominence signing their names to statements that energy can be economically transmitted electrically under existing conditions hundreds of miles, and the electrical press giving currency to these reports with editorial endorsement.

The facts are that the distances to which energy may thus be economically transmitted are limited by the original cost of the primal energy, the cost of energy with which it must locally compete after transmission, and the voltage against which it is commercially possible to insulate To simplify this statement, if we assume the first two factors to remain the same, then the distance is strictly limited by the voltages practicable.

In discussing the distribution of power over more limited distances, however, as in large cities, we are not hampered by the upper limits of practical voltage, but by other conditions,—*viz.*, the voltages at which the energy must be used in our electric lights, in our motors, and in other ways.

In these shorter transmissions, as in the longer, we find the electrical method by no means the most economical, although for general purposes of distribution and subdivision of power it is supreme.

It may be laid down as an axiom that for transmission purposes the energy should be in the potential form, and for distribution and subdivision in the kinetic.

This is clearly proven by the fact that we are transmitting coal for hundreds of miles at a cost that renders its use economical, whereas, if we assume 20,000 volts as a practicable potential to use, we cannot transmit energy electrically over perhaps thirty miles at the outside so as to compete with coal carried the same distance.

The actual cost of coal transportation by railroad is given at about half a cent per ton-mile. If we measure our tons as 2,000 pounds instead of 2,240,—allowing the 240 pounds extra of the long ton to cover losses in transit and other small incidental expenses,—and allow 5 pounds of coal to the horse-power hour (and this is liberal), our ton of coal represents to us 400 h.p. hours, and its transmission has cost us 5 mills, or .00125 cents per h.p. hour transmitted.

In our low-potential lighting systems the most advantageous arrangement possible at present, for short distances, is the three wire system with 220 volts between the outside wires; and the limit to which distribution by this means is found economical is about one mile. In allowing a loss of 240 pounds of coal in transportation for every ton, we have allowed about ten per cent. loss. This is also the usual loss allowed for transmission electrically, where the same distance is involved. The copper required for this purpose would weigh 332 pounds and cost not far from $106, if of insulated wire, and the interest on this at six per cent. would be $6.36.

Our most favorably situated electric-lighting stations do not average more than forty per cent. of their maximum output; hence $8,760 \times .40 = 3,500$ h.p. hours would have to bear the charge of $6.36 interest, or .182 cent per h.p. hour as against .00125 per h.p. hour transmitted in the potential form of coal. Or, in other words, it would cost more than 145 times as much under the conditions named to transmit energy electrically to a distance of one mile as it would to transmit it in the potential form of coal.

But we have assumed, for comparison, conditions very favorable to electricity, or, rather, very unfavorable to coal; for we have assumed it to be transported by steam, and, in converting it into the kinetic form, we have assumed nothing for the handling or second transportation to the central station, which may not be on or near a railroad.

Usually central electrical stations are placed, as the name implies in localities central to the largest demand for the output, and this more often is on expensive land removed from the railroad. A second charge is, therefore, placed on the fuel by its additional handling and transportation from the railroad or water front to the point of consumption, and this second charge usually exceeds the railroad charges, even where long rail transportation is involved. As an illustration, the cartage of coal to the Duane street New York Edison Illuminating station costs that company 45 cents per ton, and the handling of the ashes an additional 9 cents, making a total of 54 cents per ton above what the fuel would cost were the station located on the water front. Yet it has been found more economical to locate in the center of their areas of supply with the expensive ground and water rents and these additional burdens on fuel account than to locate more advantageously in these respects and incur the increased transmission losses by electricity involved in that otherwise more advantageous location.

But there are other methods of transmission of energy in the potential form even more economical than that by rail, examples of which we see in the distribution of gas and oil in pipes.

Where gas is transmitted for illuminating purposes, it is in one sense a transmission of energy in the kinetic form, just as is our water, if used for turning a water motor, but, if it be transmitted to be burned in a gas engine, which in turn is to drive a dynamo for lighting purposes, it forms an illustration again of the distribution of energy in the potential form; and, by comparing the amounts of light obtainable from a given quantity of gas used in these two ways, we again see the economy of the potential over the kinetic distribution, notwithstanding the numerous transformations involved before the potential energy of our gas takes the form of light.

Thus it is easily proved theoretically that, with our ordinary 16-candle power illuminating gas, only about one-third as much light can be obtained by burning it directly in ordinary burners as can be obtained by burning it in a gas engine and then, through the agency of the dynamo, converting it into light; the writer has seen a number of cases where, under not the most favorable conditions, fully twice as much light was thus obtained as could have been by direct consumption in the gas-burner.

In municipalities, in particular, the question of cheap distribution of power becomes of the utmost importance, and is now demanding the attention of the best engineering talent in the world. It is not enough that, when the power is delivered, it should be cheap, but it is essential that it shall be available,—that is, that it shall be in such a shape that it can be utilized with the least inconvenience for the largest variety of purposes

There is no question to day that, when energy is delivered in the electrical form, it realizes the latter conditions more nearly than they can be realized in any other way; but I have rather postulated that the electrical means of transmission is not the best at hand.

If it costs the largest electric lighting station in the United States 54 cents to bring to the sidewalk in front of its boiler-room a ton of coal which it has cost but half a cent a mile to deliver at the water front, not over two miles away, the question naturally arises: why does not the Edison Illuminating Company locate its central station on the water front, and save that 54 cents, and there convert the coal into electricity and distribute it to its customers in that form? I cite the New York Edison Illuminating Company as an example, for the reason that it is the largest station in the country, one of the most progressive, and an illustration of the practice of all the economies that engineering science has thus far endorsed. So that what I may say in regard to it is not by way of disparagement of its efficient management, but by way of emphasis of certain engineering facts which I hope to bring out. It will serve my purposes best because it stands to-day as an illustration of perhaps the best type of central-station practice in the world.

With this understanding, let us see under what disadvantages it labors.

In the first place, its various stations are located where they can reach the largest number of customers within the shortest possible distance. This means, of course, where real estate is exceedingly expensive and where interest on investment is correspondingly high. It happens in this case, as in the case of most electric-lighting stations, that this location is not favorable to cheap coal. We have seen that, by reason of the location, it is paying 54 cents more a ton for its fuel than it would have to pay were it located at the depot of supplies. It pays this penalty on some fifty thousand tons of coal per annum, which amounts to the sum of $27,000 and is equivalent to the interest at six per cent. on $450,000. This is in addition to the interest on the difference between the cost of real estate in the central portions of the city and that of prcperty along the water front, which would cost less than half as much.

Water costs to the largest consumers in New York 10 cents per 100 cubic feet. In practice we may say that the relative amounts of water consumed by condensing and non-condensing engines, irrespective of the water used for condensing, is about as 3 to 4; but, with water at 10 cents per 100 cubic feet, the use of condensing engines is commercially impossible. If the station were located on the water front, water for condensation purposes would cost practically nothing, and the saving in the water bills for steam purposes would be more than 25 per cent. This use of condensing engines would mean a saving of fuel of anywhere from 15 to 25 or more per cent., and thus one economy would render others possible.

The question naturally arises: if these statements are approximately true, why does the New York Edison Illuminating Co., why do not other electric-lighting companies in our larger cities, move a couple of miles from their present locations, so as to enjoy these economies?

The answer is simply this: that to do this they would incur, by reason of the additional distances to which they would have to transmit current, so largely increased expenses as to more than compensate for the advantages attained. That is to say, the cost of transmission over the additional distance would more than balance the savings effected, large as they would be, by the change of location.

The layman might argue that they are handicapped by the low voltage to which they are limited, and that, could they transmit at higher voltages, these disadvantages of distance would disappear.

The electrician might say: "I can transmit your current at higher voltages, and reduce it at the distributing center by storage batteries, motor generators, or static transformers"; yet this is not done. The reason is that conservative engineers have not been convinced that even these resources would prove more economical than present practice, and, with the great certainty with which electrical calculations are verified in practice, it is not probable that their conclusions are materially wrong. Hence we must conclude that neither the coal cart or electrical means satisfactorily solves the question of local transmission.

I use the term "local transmission" in a very different sense from the term "local distribution"; while I believe that the electrical method is by far the best known for local distribution, it seems for local transmission not yet equal to the coal cart. For distribution purposes, however, the coal cart, while still more largely employed, must give way to electricity.

Omitting for the present the cheaper methods of getting our energy to the centers of distribution, let us consider the requisites for its cheapest conversion at that point into the kinetic foim.

Reference has already been made to the large tax upon the cost of power in the form of the fixed charges due to high rentals. These should be lessened, if possible, by using less space. That is to say, our apparatus for the conversion from the potential into the kinetic form should be as compact as possible, and this apparatus should be used as nearly continuously as the demands of the service will permit, and, while idle, should be no greater charge on the cost of power than the interest on the investment.

Evidently, driving dynamos by steam engines does not answer either condition, and the situation is made still worse by the small proportion of the total capacity of the plant required of any machinery erected for commercial distribution of power at the present day.

In this country there are few central stations whose average supply is as high as forty per cent. of their maximum capacity, and in England and on the continent probably none. Therefore these interest charges on the expensive real estate and conversion charges are, if we assume a load factor of forty per cent., two and a half times what they would be if only sufficient apparatus were installed to supply the same aggregate demand continuously used. Thus, if we allow six per cent. interest on the investment as it is made to-day, it is equivalent to fifteen per cent. on that which would be adequate if the investment were utilized to the best advantage.

Very much the same may be said of the insurance, labor, and administration charges, for these remain practically constant, whether the apparatus is employed to its fullest capacity or to only forty per cent. of it. These sources of expense can only partially be avoided, because we cannot regulate the demands. As purveyors of power we must meet the demands as they exist, in the best way that we can, but there is usually another source of expense in the production of power which is quite as serious as any of those mentioned, and which should be more easily dealt with,—*viz.*, the stand-by losses of our steam machinery. When the latter is idle, it is not only the insurance, taxes, and interest charges that continue, but also a large portion of the fuel and labor charges.

It has been estimated by very competent authority that the stand-by losses of the boilers in an English electric-light station—*viz.*, the amount of coal they consume while banked during light load—amounts to ten per cent. of the total coal consumed in the station.

While it is a fact that in most industries the total cost of power does not constitute more than 10 per cent. of the cost of the finished product, we must remember that in this particular industry—the power industry—it constitutes 100 per cent. of the cost of the finished product. Every item of expense, therefore, must be far more closely scrutinized than it would be under other conditions.

To illustrate the combined effects of the above sources of expense I have given elsewhere* the estimated cost of power under present methods, but with steady load, as $48.68 per horse power per year with coal at $1.75 per ton, and $65.62 per year with coal at $3.50 per ton, whereas, under the same conditions, except that the load factor was assumed to be twenty-five instead of one hundred per cent., it would be $117.78 with coal at $1.75, and $148.40 at $3.50.

The most obvious method of overcoming these losses, and the one most advocated at present, is the conversion of the energy immediately upon generation, or at some subsequent stage, into the potential form,—*viz.*, storing it up during light demand for use at times of excessive demand, thus equalizing the load on the generating plant, so that the latter may be employed continuously to its full capacity.

As showing the effect of storage at the successive stages of the generation of electrical power, I quote from the same paper as follows:

The saving by introducing storage		Cost of horse power at this stage.
between boiler and engine is	$30.69	$ 48.68
" engine and dynamo	23.56	87.09
" dynamo and distribution	14.85	117.78

That is to say, if the storage cost nothing, the saving at those

* "The Storage of Energy Essential to Economy of Working in Central Stations." A paper read before the National Electric Light Association, February 20, 1895.

stages would amount to the sums mentioned under the conditions assumed. But storage cannot be obtained for nothing, and it therefore becomes necessary to consider the expense and the efficiencies of the various methods of storage of energy most in use.

It is evident that in many situations the space and weight efficiency of the storage may become quite as important as the conversional efficiency, and for this reason the following comparison is given :

According to the latest catalogue, the largest storage battery listed weighs 3,970 pounds complete, occupies 7 cubic feet of space, and has a storage capacity of 25.7 h. p. hours under normal discharge, or 19.3 h. p. hours under rapid discharge. According to Mr. A. E. Childs,* such a cell can be installed complete for about $30 per h. p. capacity. If discharged in 3 hours, the h. p. capacity of such a cell is about 6 h. p. Its space efficiency is, therefore, a little less than 3 h. p. hours per cubic foot, and its weight efficiency 16½ pounds per h. p. hour at normal discharge.

In Halpin's thermal storage, working under 265 pounds pressure, which corresponds to a temperature of 406° F., 4.06 cubic feet for condensing engines and 6.4 cubic feet for non-condensing engines are required per effective mechanical h. p. hour, which, assuming a dynamo efficiency of 90 per cent., becomes 4.5 cubic feet for the former and 7 cubic feet for the latter.

In water storage, if the elevation were 100 feet, 317 cubic feet would be required per h. p. mechanical, or 352 cubic feet per electrical, h. p. hour.

In gas storage, if we assume 16-c. p. illuminating gas, 20 to 25 cubic feet capacity are required, and, with Dowson fuel gas, from 75 to 100 cubic feet.

All of these methods, except water and gas storage, involve material losses in storage, either frictional or conversional, and all except gas storage involve transmission in the kinetic form, or else by the coal cart, which, as has been pointed out, is expensive. All, except gas and water, involve also the use of boilers, and these involve real estate and stand-by losses.

In our most compact central stations the floor space is about equally divided between the boiler room and the engine and dynamo room. To do away with the boiler room would, therefore, effect an economy that is exceedingly important where real estate is high and where the load varies as it does in electric light and power stations.

It is clear that, if we could convert our coal into a gaseous fuel at

* "Discussion of Storage-Battery Applications." *Trans. Am. Inst. E. E.*, November 20, 1895.

the water front or railroad line, and transmit it in its prepared state to gas engines located at centers of distribution, we could save half of our floor area, and avoid the stand-by and condensation losses, etc., of our boiler plants, for the stand-by would then be our gas main, which, if it did not leak, would cause no losses while the engines were idle, and involve no extra expenditure of fuel corresponding to that required in getting up steam and in the drawing of fires.

The late Mr. Denny Lane, who was a gas engineer of prominence, stated before the Institution of Civil Engineers that "with ordinary town gas of 16 candle power, 3,000 h. p. could be sent a distance of 1 mile for an expenditure of 1 h. p.,—an economy of distribution far exceeding that possessed by any other system, either hydraulic, pneumatic, or electric, being only $\frac{1}{30}$ per cent. of the power conveyed."

To carry this line of argument a little further, I have assumed, first, that we wish to transmit our gas through a 12-inch pipe to a distance of 5,000 yards, or nearly three miles. It is assumed that this gas has a specific gravity of .55 as compared with air, and that its calorific power is such that, when burned in a gas engine under fair conditions, it will require 25 cubic feet to produce 1 h. p. hour.

These figures, carried out for pressures varying from 1 inch of water to 10 inches of water, are given in Table I, and show that, with 1 inch of water, 500 h. p. can be delivered through a 12-inch pipe having 25 90°-bends to a distance of 5,000 yards with an expenditure of but $\frac{7}{1000}$ of 1 per cent. of the energy transmitted, and that, with a pressure of 10 inches of water, 1,600 h. p. can be delivered with an expenditure of $\frac{7}{100}$ per cent. of the energy delivered.

TABLE I.

TRANSMISSION OF GAS .55 SP. GR., 5,000 YDS., THROUGH 12-INCH PIPE WITH 90°-BENDS EVERY 200 YDS., WITH VARIOUS INITIAL PRESSURES.

Inches Water Pressure.	Cu. ft. delivered	Velocity of Flow in ft. per second.	Increase of pressure for each 90°-bend in pipe.	Total increase pressure for 25 bends.	Total Initial Pressure in Inches Required to Deliver Gas.	H. P. Delivered 25 cu ft. 1 h.p.h.	Ft. lbs. per sec. consumed in transmission.	Per cent. of Power Transmitted Consumed in Transmission.
1 inch	12,500	4 ft.	.0016 in.	.04 in.	1.04 in.	500	17.3	.007
2 "	18,000	6 "	.0034 "	.085 "	2.085 "	720	51.5	.013
3 "	23,000	8 "	.006 "	.1495 "	3.15 "	920	105.12	.0208
4 "	25,500	8.8 "	.0076 "	.189 "	4.189 "	1020	151.5	.027
5 "	28,000	9.6 "	.0086 "	.215 "	5.215 "	1120	204.7	.033
6 "	32,000	11. "	.0113 "	.28 "	6.28 "	1280	284.	.04
7 "	34,000	12. "	.0135 "	.34 "	7.34 "	1360	359.	.048
8 "	36,000	12.5 "	.0147 "	.39 "	8.39 "	1440	430.	.054
9 "	38,500	13. "	.0158 "	.4 "	9.4 "	1540	501.	.06
10 "	40,000	14. "	.0183 "	.46 "	10.46 "	1600	602.	.07

Cast-iron pipe 12 inches in diameter and ¾ of an inch thick weighs about 300 pounds per yard, and the total length of 5,000 yards would, therefore, weigh about 800 tons. This can be bought in the open market to day for $20 per ton,—an investment of $16,000.

If we should endeavor to deliver this same amount of energy electrically at 10,000 volts, with the same efficiency of transmission, it would require twenty-eight 0000 B. & S. wires, and these would weigh 538,020 pounds. If we charge nothing for insulation, and put the cost of bare copper down to the ridiculously low figure of 12 cents per pound, we have an investment of $64,562, or four times that for the gas mains. As a matter of fact, even granting such concessions as I have made to the electrical method, there is another and all-important element which cannot be ignored,—*viz.*, that we have no way of using the electrical current at anything like 10,000 volts. To make it available, it must be transformed down to at least something like the voltages now in use, and this means additional losses in energy and additional invested capital. If we should admit that it is practicable to generate the direct current at 10,000 volts, then the storage battery or motor generator would be available; but the highest efficiencies claimed for either of these admits a loss of several per cent.; so that, even if the electrical transmission were of 100 per cent. efficiency, the losses in rendering the current available by stepping down the voltage would be several hundred per cent. greater than the highest losses given in Table I for gas transmission.

With the alternating current very much higher voltages might be used, if suitable insulation could be procured, and thus the efficiency of transmission increased over that claimed for gas, and the cost of copper correspondingly decreased; but the transformation problem still obtrudes itself, and the ultimate efficiency would still be several per cent. less than that claimed for gas: so that it may be said that it is not theoretically possible to transmit energy electrically in municipalities as efficiently or as cheaply as it is actually accomplished today by gas.

These statements apply, however, only to comparatively short distances, for it will be seen, by reference to Table I, that the efficiency of gas transmission varies inversely as the pressure. With electricity, however, the efficiency increases directly as the pressure, so that a point will be reached where the two curves cross each other and the relative conditions are reversed.

(*To be continued.*)

PAVEMENT CONSTRUCTION AND CITY GROWTH.

By Stevenson Towle.

THE health, wealth, and comfort of a city depend in a large degree upon the character of its pavements.

The ancients appreciated more fully than we the value of well-paved roads, and the building of these roads immediately followed every conquest; this was deemed necessary in order to fully develop the resources of the country and bring to the government the greatest possible revenue. The Roman domain was extended more for revenue and profit than for glory; good roads and their maintenance were considered essential to this. So thoroughly and well were these roads built that many of them are in use to this day, especially in Spain and in the far East.

Merchants and business men have come to realize that their ability to do business and compete with other cities depends on the ease and cheapness with which goods can be carted and handled in transit through a city. Good pavements mean increased profits; heavier and larger loads can be handled with advantage. It was not until about thirty years ago that the great commercial cities of Europe first became convinced that their welfare depended on their having suitable pavements. They immediately began to construct substantial pavements, on a comprehensive plan. London, Liverpool, Paris, and Berlin have spent vast sums for this purpose, and have found these expenditures a most profitable investment, the improved pavements enabling their merchants and manufacturers, by the lessening in the cost of hauling and handling goods within the city limits, to control the markets of the world. The most substantial pavements were laid, and the cost was not considered. These cities also realized the fact that their interests were harmonious with those of the great railroads and steamship companies having their terminals within the city, and that therefore depots, wharves, and warehouses should be connected by well-paved streets. While these improvements were being made abroad, the merchants of this country were losing vast sums of money in trade, due in a great measure to the extra cost they were compelled to bear by reason of the cost of carting goods over bad pavements. New York, in particular, was a sufferer, being the great *entrepot* for foreign and domestic commerce. Merchants were discouraged in their efforts to compete with foreign cities.

In Europe the national governments exercise paternal care over cities, and direct the improvements to be made. In this country the conditions are different; the municipal government cannot make important improvements without obtaining the sanction of the State legislature. This body is not always open to conviction, and the legislature of New York has been no exception. It was with the greatest difficulty that it could be made to see the vital necessity of improving the pavements of this city, and to realize the great loss and injury that our merchants were sustaining by reason of their neglect. It was only by the efforts of the chamber of commerce and of Mayor Hewitt and his engineer expert, who had recently examined the best pavements of Europe, that the legislature was prevailed upon in 1889 to allow the city to expend $1,000,000 annually in improving its pavements. The fruits of this liberality are everywhere apparent; merchants and manufacturers immediately felt the advantage; great manufacturing concerns found it to their interest to retain their business in the city. The experience of New York in its efforts to have better pavements is similar to that of other cities, at home and abroad, and a short statement of the conditions that prevailed and the improvements that have so far been made may be of service.

Originally the pavements were mostly of cobble stones; afterwards of Belgian blocks, and sometimes of granite blocks on a sand foundation. The pleasure-drives or boulevards were paved with macadam pavement. The old cobble stones and Belgian blocks were utterly inadequate for commercial traffic, and were soon completely destroyed. Various kinds of pavement were tried. The first was the Russ patent pavement, laid on Broadway in 1849 (about 2½ miles in length). It was the most substantial pavement that could be devised, formed of syenite blocks twelve inches wide and about the same in depth, laid in diagonal courses on a substantial concrete foundation. This pavement was not satisfactory, owing to its slipperiness, the blocks being wide and the joints close, thus affording no foothold for horses. No more of this pavement was laid. The next trial was that of the Belgian-block pavement, first introduced and laid in this country in 1852. It was made of small trap blocks quarried from the palisades, and laid on a sand foundation. It was a very satisfactory pavement for a short time; it was durable and easily cleaned, and such an improvement on the old cobble-stone pavement that the latter was soon almost entirely replaced by it. In a few years this pavement was extensively laid throughout the city, especially in the business parts. The merchants and carters naturally took advantage of this smoothness and the ease with which heavy loads could be drawn on the new streets, and increased the weight of loads to as much as the horses could draw. The weight of these loads in many instances was much more than the pavements could bear, and as a result this comparatively satisfactory pavement was soon destroyed, and a stronger pavement had to be provided. To this end the old Russ pavement on Broadway, although still intact, was replaced by the improved granite pavement, similar to the improved pavement being laid in London. Unfortunately for the city, the contractor had procured a patent for it, and the pavement could not be used by the city, for the reason that all patent pavements were prohibited by law. Finally the patent was invalidated, and in 1882 the city resumed the laying of this pavement on several busy thoroughfares. Its great cost, however, due to the expense of quarrying and making the blocks, precluded its general use. It was thought to lessen the cost by omitting the concrete foundation, and for several years pavements were laid in that way. This cheapened pavement was a great improvement on the old Belgian pavement, and was capable of sustaining heavier loads; and for a short time it seemed to meet the requirements of commerce. But it wore out under the increased loads, for lack of proper foundation. Fortunately, the introduction of improved machinery and scientific methods in the quarrying of the blocks had so far reduced their cost that the pavement could be laid on a substantial foundation at a price less than that first paid for the pavement without the concrete base. It was this cheapening of the cost of granite pavements and the absolute necessity of the concrete base that induced the legislature to authorize the new pavement. In determining the kind of pavement best suited to the different traffic, the experience furnished by the cities of London, Paris, and Berlin was a great aid. In making the selection, business needs were first considered; then the residential sections, where old, worn-out Belgian pavements prevailed; then the tenement district; and lastly the pleasure-drives. Cobble-stone and Belgian-block pavements will not be considered here, as they are not first-class pavements.

Brick pavements are not an experiment, having been laid for the past two hundred years in Holland, where many of them are in a satisfactory condition to this day. They are now being extensively laid in many of the cities in our western States, where they prove themselves suitable for moderate traffic. The sample block laid in New York is wearing satisfactorily, and has had little or no repairs since laid five years ago. They are less noisy than stone, and afford easy traction for horses, and, when laid with cemented joints (grouted), absorb but little rain-fall They are to be preferred, where the traffic is light, to macadam or stone. Great care should be taken in selecting a brick of proper quality. The hardness is no test of suitableness for a pavement, for some of the hardest brick do not wear well. Many failures of brick pavements in this country were due to defective foundation, and to the fact that bricks were used which were obtained from local sources, because they were cheap, and in order to foster the home industry. The bricks should be hard and well burnt throughout, of uniform size and compact construction, capable of bearing the usual test considered necessary and sufficient for this kind of pavement. First, they should sustain a pressure of 13,000 pounds to the square inch. Second, they should not be reduced more than 3 per cent. in weight by abrasion. Third, they should not absorb more than 2½ per cent. of water in twenty-four hours. Tests should be made, not only before accepting a particular quality of brick, but frequently during the laying. The best practice is to lay the work on a concrete foundation from four to six inches thick, according to the traffic. A bed of fine sand from ½ to 1 inch in thickness should intervene between the concrete and the brick. It is the practice with some engineers, where travel is heavy, not to use the sand bed, but to lay the bricks directly on a bed of hydraulic cement mortar. There is considerable difference in opinion, however, as to whether a pavement so laid is as durable as one laid on a simple bed of sand. The brick should be laid with very close joints in courses at right angles to the curb lines, and at street intersections in diagonal courses. Adjoining railroad tracks, it is found better to lay one row of stone blocks to receive the extra travel at this point. The brick being laid and the course accurately adjusted to the true line, the joints of the pavement are filled either with very fine hot sand, for ordinary traffic, or with Portland-cement grout for ordinary and heavy traffic. In order to secure the best material and workmanship, it is absolutely essential to have the contractor guarantee his work for at least five years; for even the most frequent and accurate tests and careful selections do not insure an absolutely uniform texture of brick; the test of actual wear is the only reliable one.

Granite pavements laid on concrete foundations, similar to those of London, Liverpool, and Manchester, are most durable for business purposes, and have been adopted for use in New York. The pavement is laid on a foundation of six inches of concrete with granite blocks 3½ to 4 inches in width, 7 to 8 inches in depth, and 8 to 10 inches in length. These dimensions conform to the London specifications, except that greater variations in the depth of the block were allowed in the American pavement. While this greater variation lessens cost, it is not economical, as it causes the surface of the pavement to wear unevenly, the shallower blocks sinking below the deeper ones. The inequality of the under side of the pavement soon becomes transferred to the surface, producing a roughness and inequality that destroy the pavement and render haulage difficult and expensive. There have been so many improvements in the methods of getting out paving blocks and quarrying and preparing them, and the price has been so greatly reduced, that there is no longer a reason to use blocks varying in depth. In laying a first-class granite pavement, the carriage-way is excavated for the required depth to receive the foundation, and made compact by ramming and rolling. All unsuitable material not insuring a firm foundation should be removed and replaced by proper material. On this bed the concrete foundation should be laid; it should have a depth of 6 to 8 inches, according to the weight of traffic. The American Portland cement is to be preferred as stronger and costing no more than the natural cements. The concrete should be allowed to set for three days before laying the pavement. A layer of fine sand is spread upon the foundation to a sufficient depth to bring the pavement to a proper grade. The blocks are then laid in the course at right angles to the curbs, except at street intersections, where the courses are laid diagonally, in order to provide for the cross travel. The blocks are rammed to near the finished grade, hot paving gravel is poured into the joints, the blocks are again rammed to grade, and the courses aligned. Hot paving cement is then poured into the joints until they are filled. The best paving mixture, one that resists the heat of summer and the frosts of winter, is three parts of coal tar with one of asphaltum. Great care should be taken to pour the paving cement while boiling. Gravel is then spread over the cemented joint to absorb any excess of paving cement.

The great success of the asphalt pavements now being laid in this country proves that they are well suited for residential streets, and likewise for streets having the heaviest traffic. They are particularly adapted for business streets on account of the facility with which the pavements can be restored. The objections of the carters have entirely disappeared, for they find that much heavier loads can be carted, with greater safety. The advantage on the score of cost is now very much in favor of asphalt; this is due to the great improvements in the pavement. An asphalt pavement can be laid so as to require little or no repairs for five or six years, or even fifteen years. This is due to competition and improvements in the machinery for mixing and laying the pavement, and to experience obtained in compounding and laying it, and also to the knowledge that the cost of maintenance is much less than was previously estimated.

The comparative durability of the asphalt pavement is clearly shown on many business streets. The pavement, to be successful, must be composed of the best substances, mixed and laid in the best manner, with improved machinery and scientific methods. The failure of many of the asphalt pavements is due to not using proper asphalt. It is the experience of New York that the best asphalt pavements are laid with the Trinidad Pitch Lake Asphalt, Alcatraz from California, and Bermudez from Venezuela, the Sicilian mines at Ragusa and ver Wohle, and the Swiss mines of Val de Travers. Ordinarily the pavement is laid on a concrete foundation, although those that have been laid on the old stone pavement or on macadam pavement have proved equally durable. The durability of the pavement depends on the asphaltum, and the greatest care should be used in selecting it.

When pavements are of Trinidad, Alcatraz, or Bermudez asphalt, the wearing surface is composed of refined asphaltum, heavy petroleum oil or fluid natural bitumen, fine sand, and powdered carbonate of lime. The asphaltic cement must be composed of 100 parts of pure asphalt, and from 15 to 20 parts of residuum or natural bituminous oil. In compounding the pavement, from 12 to 15 per cent. of this cement is mixed with from 70 to 83 per cent. of sand, according to the fineness and quality, and from 5 to 15 per cent. of pulverized carbonate of lime, as may be necessary; the pulverized carbonate of lime may be omitted when the quality of the sand warrants it. The sand is heated to about 300 degrees F., and the carbonate of lime is then added in the required proportions; the asphaltic cement is heated to a temperature of 300 degrees F., and then mixed with the hot sand, care being taken that the temperature is nearly uniform for both.

The paving mixture, when it reaches the ground or work where it is to be used, should have a temperature of not less than 250 degrees F.; this heat can be maintained during a transit of 1½ hours. As soon as the mixture reaches the work, it must be spread evenly to such depth that, when ultimately compressed, it will have a thickness of from 1½ to 2½ inches, as may be required. The first compression, which is a light one, should be done by hand rollers, and the final compression by a steam roller weighing not less than 250 pounds to the inch-run. This rolling should continue for not less than five hours for every thousand square yards of surface. It is found advisable to reinforce the asphalt pavement along the gutters for about one foot in width, by spreading and saturating the pavement with pure hot asphalt, which should then be thoroughly ironed. This prevents the decay of the pavement due to the lodging of water.

Where the pavement is composed of natural lime stone rock, the manufacture is very different: the rock must be finely crushed and pulverized; too great care cannot be taken at this stage of the process. The powder is then finely screened. It is generally necessary to mix different kinds of asphaltic rock in order to get the proper proportions of asphalt. Some of the rock asphalts are rich in bitumen while others are lacking therein ; the proper proportion of each gives the desired mixture. This mixing is always done before the rock is ground. The powder, when mixed, should contain from 9 to 12 per cent. of bitumen and from 80 to 91 per cent. of the pure carbonate of lime ; the mixture must be absolutely free from quartz, sulphates, iron pyrites, or alumina. It is advisable to make the thickness 2½ inches, so as to allow of gradual compression under actual wear ; it is impossible to compress the asphalt when first laid, and its ultimate or final compression can be had only by actual traffic.

Macadam pavements are not recommended for cities, and should not be laid except for pleasure-drives ; when laid, they should be of the very best material and workmanship. None but the hardest stones should be used ; particular care must be taken in the preparation of the foundation and in selecting the very hardest stone for the top or wearing surface,—preferably trap rock, syenite, or granite, in the order named. The foundation should be what is known as Telford foundation. For light pleasure-drives a foundation of six inches of broken stone may be substituted for the Telford, but it is found more costly in the end. The course of broken stone following the Telford may be of the same material as Telford, but trap rock, syenite, granite, or lime stone is preferred. The stone may vary from 2 to 4 inches in diameter. This course should be evenly spread and only lightly rolled, without watering, and the surface should be left uneven to bond the next or wearing course, which should be of the hardest rock obtainable, should vary but little from 2 inches in diameter, and should be as nearly cubical as possible. The binding material for the course and top dressing should be of screenings and the same rock, as near ½-inch in size as possible,—free too from dust and dirt. The course should be regularly and compactly rolled with a roller weighing at least 10 tons, and sufficient water should be used to thoroughly saturate and wash the screenings into the voids and interstices of the broken stone ; the screenings should be rolled, until the surface is even and unyielding. On grades of over 1 per cent. it is advisable to pave the gutters ; the stones are best laid in courses, at right angles to the curb.

Some twenty thousand square yards of asphalt block pavement has been laid in New York within the past five years, and proved well adapted for light traffic. It is very much smoother and less noisy than any of the stone or brick pavements. So close are its joints that, under the influence of heat and traffic, the blocks become cemented together, forming almost a water proof pavement. There has been a great improvement in the manufacture of these blocks, tending to make them more durable. They are now made with broken trap rock, instead of the soft lime stone rock previously used. Adjoining railroad tracks, asphalt blocks not being suitable, it is advisable to use a row of stone blocks. It is claimed that this pavement is less slippery than sheet asphalt ; this may be so to a limited extent, but not generally, excepting on steep grades, for the pavement that has recently been laid, with particularly close joints, is almost as smooth as the sheet asphalt. It has this advantage : it can be laid remote from the factory and by ordinary pavers, not requiring the skill and machinery necessary for sheet-asphalt pavements. The blocks are of uniform size,—in width 4 inches, in depth 4 inches, and in length 12 inches. The best practice is to lay the pavement on a foundation of concrete from 4 to 6 inches in thickness. Upon this foundation is spread a layer of fine sharp sand ½ inch in thickness to serve as a cushion. The blocks are laid in courses at right angles to the curbs, and, at street intersections diagonal thereto, the block should be broken by the lap of four inches. After about twenty courses of brick have been laid, the courses should be adjusted to an exact line. The blocks should then be rammed to an unyielding bed, and the surface made perfectly true and uniform and properly graded. When the ramming is completed, a layer of fine dry sand should be spread freely over the surface and swept into the joints. For light traffic, and where it is necessary to save expense, the concrete foundation can be omitted ; this is generally the practice outside of New York.

The failure of wood pavement in this country did not prevent its extensive use in London and Paris, where its success was due to excellence of construction and maintenance, involving a cost at least double that of the best asphalt or stone pavement ; in those cities cost is not considered. A noiseless comfortable pavement is insisted on, no matter what the expense ; and wood in this respect has been most satisfactory.

A substantial concrete foundation is necessary to this pavement. Six inches in thickness is considered ample, although in rare instances the London pavements have been laid on eight inches of concrete. The best European practice is to use blocks not treated with chemicals to prevent their decay ; all chemical processes have been abandoned, except that of impregnation with the oil of creosote. There is now being used in London a wood from Australia entitled the Karri wood. This wood is compact and very solid, and, it is claimed, more lasting than the ordinary spruces, pines, and other woods used for pavement, even when treated with creosote or by any of the chemical preserving processes. This wood is extremely hard and compact, but makes one of the slipperiest of wood pavements. A sample was laid in Twentieth street, New York, about a year ago, following the English specifications.

The comparative slipperiness of the different kinds of pavements is now definitely known from actual observation. The tables, observations, and conclusions of European authorities are not applicable to this country, where the conditions are different,—not only the climate and the characteristics of the pavement, but the manner of shoeing the horses. In Europe granite pavements are laid with a smooth surface and very close joints, and consequently are more slippery than the granite pavements in this country, where the joints are open, smooth surface and close joints affording the smoothly shod horse less foothold. The rock asphalt used in Europe is free from grit, polishes very smooth, and becomes extremely slippery, while the Trinidad or California asphalt used in this country, being composed principally of sharp sand, affords a gritty surface and is less slippery. In this country the opportunity of observing the comparative slipperiness of wood pavements is very limited : but experiments in Europe show them to be extremely slippery at times,—more so than stone or asphalt, especially when there is a slight frost.

The cost of all kinds of pavement has been greatly reduced within the past few years, owing principally to competition and improved methods of quarrying and cutting the stone blocks. Asphalt is now mined, and loaded directly into the vessels, by labor-saving and novel machinery. Thus the price of asphalt pavement in New York, with the usual five years' guarantee, has been reduced from $3.05 a square yard, in 1894, to $2.23, in 1896. The following table shows the average prices of asphalt pavement for the years 1894, 1895, and 1896.

	1894.	1895.	1896.
For granite on sand	$2.87	$2.33	$2.15
For granite on concrete	3.50	3.15	2.75
Asphalt with 5 years' guarantee, on concrete	3.05	2.90	2.23
Asphalt with 15 years' guarantee on the old pavement	3.85	3.35	2.69

The reduction in the price of all other kinds of pavement has been equally great.

The different kinds of pavements require special cross-grades, or crowns. Heretofore pavements have been laid on very steep crowns, as this was considered necessary to their strength ; also for the purpose of quicker surface drainage. The practice originated with the macadam pavement that generally prevailed in cities, and has been continued up to a very recent date. The confinement of the travel to the level portion in the center of the roadway caused this part of the pavement to wear faster than the sides, which were avoided on account of their steep side-grade ; it is found that the pavement lasts longer, and is more satisfactory generally, when paved on a slight crown. It is now the practice to make this crown as slight as possible, only sufficient for surface drainage. The flat uniform roadway, where wear is distributed over the full width, wears longer, and the horses are not so liable to slip (horses usually fall from slipping sideways); steep cross-grades, or crowns, are in no way necessary to the stability of the pavement. The crowns best suited for streets having grades up to 4 per cent. are found to be, for asphalt, wood, and brick, $\frac{1}{75}$ to $\frac{1}{100}$ of the width; for granite, $\frac{1}{17}$; for macadam, $\frac{1}{50}$.

The width of the wheel-tire has a marked effect on the durability of the pavement. Throughout Europe the width of the tire is regulated by law according to the weight of the load to be drawn. In this country the width of the tire is not compulsory. It is not at all proportioned to the load. If carters were compelled to restore the pavement injured by the too narrow tire, they would soon correct the abuse. An instance of this came to my notice on an application of the Metropolitan Traction Company for permission to cart an exceptionally heavy load, weighing seventy-two tons. The department required the company to make good any damage done to the pavement; consequently it built a special truck with tires ten inches in width.

In no instance is the benefit of a noiseless pavement more noticeable than about schools and hospitals, and on streets occupied exclusively by the poor. Physicians and health authorities bear witness to the benefits that have been derived from asphalt pavements, as not only noiseless, but preventing all liquid wastes from saturating the ground beneath them. It is this characteristic of the asphalt pavement that has improved the health of several large districts in this city occupied exclusively by tenement houses of the poorest kind. These streets were originally paved with the Belgian or cobble pavement, and had worn in ruts, in which the refuse water lodged. In this way the soil became saturated with filth, giving out poisonous air. Since these neighborhoods have been paved with asphalt, physicians and the health board have observed a marked absence of malarial diseases, and a lessening of the death rate. Good pavements not only promote the health of the community, but facilitate the renting of houses, and in no instance is this rental increase more noticeable than when a macadam pavement has been replaced by asphalt. In many instances rents on such streets have been increased by one-third, and it is safe to estimate that improved pavements have increased the rental of dwellings through the city at least ten per cent.,—far more on residential streets where asphalt pavement has replaced the cobble or Belgian pavement.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

SURVEYING the field of human effort as it actually exists to day in America, many large manufacturing establishments are found which have never had a strike, or any serious disagreement between the management and the workmen, and in which, although the wealth of the employer has vastly increased, the workmen are making small, but constant, gains in money and in comfortable living. Hence it appears that workmen can be happy and contented, and can in these particular cases lead lives which are not lacking in any essential of the very best living which workmen have the capacity to enjoy, without any change whatever from existing conditions of trade, commerce, or society.

If this result of financial success, coupled with full and happy lives of the workmen, can be reached in some instances without resort to coöperation or a paternal form of government or a general redistribution of wealth, it can be reached in many instances under existing conditions of trade and social economy, and so finally, by mere force of good example, it may become the rule instead of the exception that employers and workmen shall conduct their joint exertions for the enrichment and betterment of the world at large, in that peace and harmony and mutual happiness which must be held as the highest good of human existence.

It therefore seems highly important that the precise means by which this condition of harmonious effort is secured by these successful employers of wage-earners should be fully presented to the public, so that they may be clearly understood and thereby aid in the profitable management of industrial enterprises and the alleviation of those frightful miseries which seem the inevitable heritage of the workman in some places.

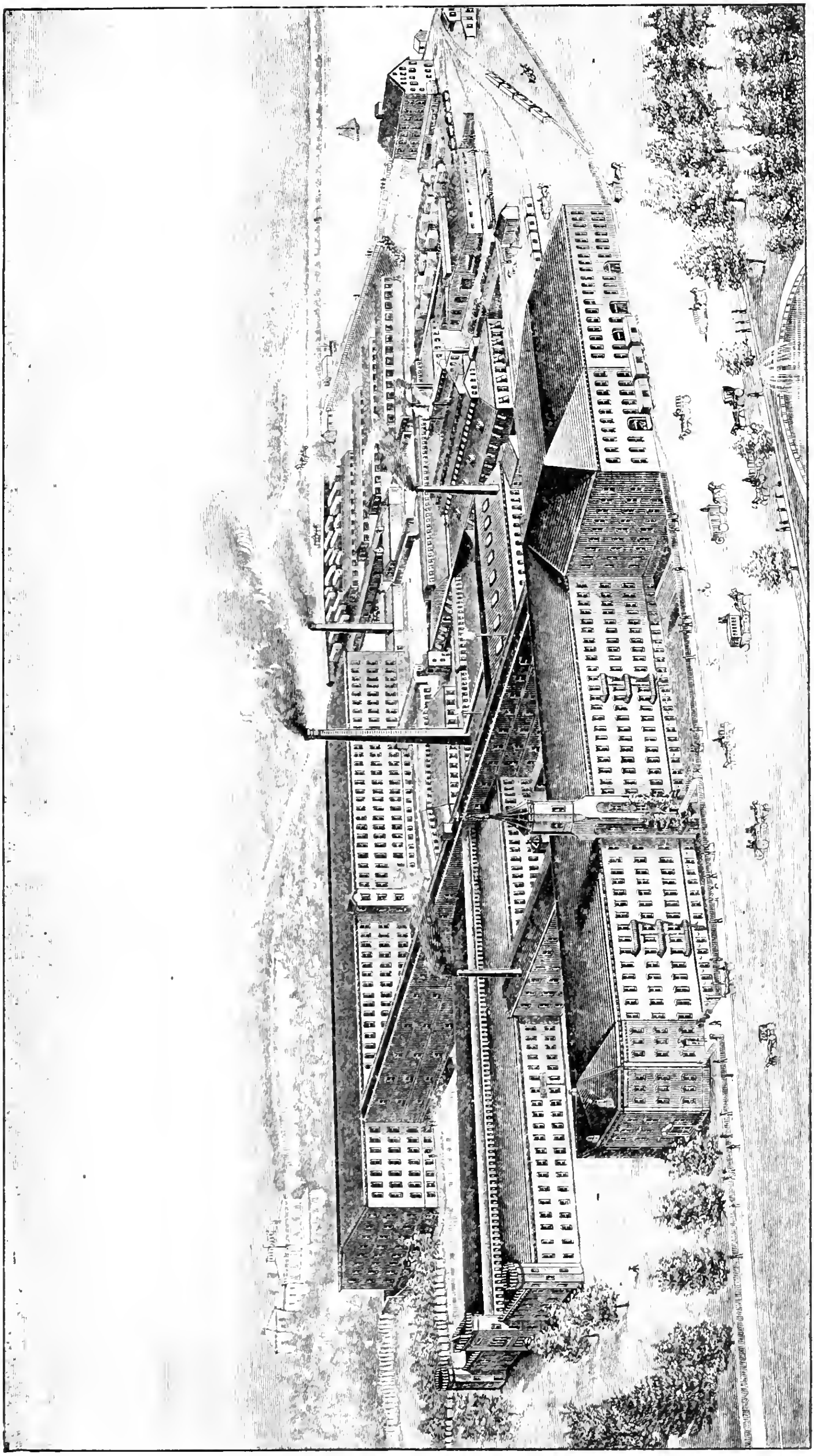
With this end in view, six successful establishments which have never had a strike or any serious difference of opinion between the management and the men have been selected for description. Each of these six concerns deals differently with its labor, all are highly-esteemed commercial successes, and all retain their workmen so long as their services are desired.

The first of these examples of fortunate wage-working has been selected because it has no settled or formulated policy, no defined method of adjusting pay-rates, and hence no conspicuous or readily-defined guarantee of that immunity from labor troubles which nevertheless has been enjoyed for well towards a century of operation by the Whitin Shops located at Whitinsville, Mass., fourteen miles from Worcester, twenty-eight miles from Providence, and forty-four miles from Boston. The Whitin shops are reached from Whitin station on the Providence & Worcester line *via* a private electric road a mile and a quarter long, for freight, and a line of stages which meet the trains, for passengers.

Pictures of the Thomson-Houston electric locomotive, which can handle two loaded freight-cars, and of the track, are given.

The beginning of Whitinsville in the hands of the paleface dates back to 1660, when the general court of Massachusetts chose Mr. Peter Bracket and Ensign Moses Paine "for to purchase a title of the Indians containing about eight miles square, about fifteen miles from Medfield Town, at a place commonly called Masconsapong."

The tract was bought from Great John and three other Nipmuck chiefs for "the summe of twenty-four pounds sterling," and the deed signed April 22, 1661; and all interest in the tract of land covered by this deed was assigned to the selectmen of the town of Mendon, May 12, 1662. Civilization proceeded so gradually that in September, 1730, the town voted an appropriation of £4 for killing wild cats, and the bounty on wolf scalps was not withdrawn until May 23, 1751. In 1772 a part of this tract became the "district" of Northbridge, containing 10,551 acres, and this "district" was raised to be the "Town" of Northbridge in 1786. The Blackstone river runs through Northbridge about one mile from its eastern border, and the Mumford river, on the banks of which the Whitin shops now stand, runs through the southwestern corner. Both these rapid streams gave good water-powers for nine months in the year naturally, and that of the Mumford river has been increased very materially by a system of artificial-storage reservoirs, as will be specified later. Between the two rivers rises Northbridge hill, a broad ridge with its highest point near the middle, falling somewhat towards the north; the Whitin (pronounced "White-in") Shops are at the south end of the hill, and mainly on the north side of the Mumford river. The Whitin water-power was first developed by the erection of Samuel Terry's saw mill in 1727 or 1728. There was iron ore at hand, as in 1700 the town of Mendon, which at that time included Northbridge and Whitinsville, voted that no person should carry any iron ore out of or from the town common under a penalty of 20 shillings for each load, 10 shillings to go to the informer and 10 to the town treasury, and an iron works was established at Mumford Falls in 1727 by Samuel Terry, clerk of



THE WHITIN SHOPS, LOOKING SOUTH FROM THE HILL.

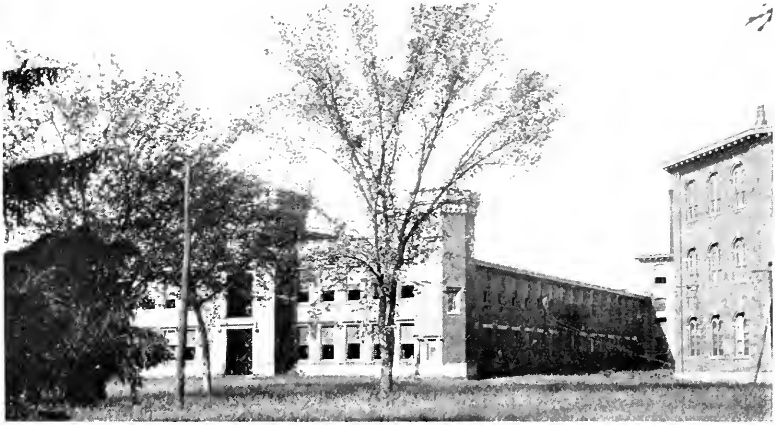
Barrington, Mass. The next year Terry sold the saw-mill and iron-works to Hugh Hall of Boston for £212, gold; there was at that day a depreciated colonial currency, so that for a long time all statements of sale contained two numerical values, one currency and the other gold. Hall sold to Gershom Keys, trader, of Boston, in 1732, for £212, gold, and in 1733 Keys sold all the land and the saw-mill and half the iron-works to Jonathan Bacon, gent., of Bedford, for £368, gold. Keys soon bought back Bacon's interest in the iron-works, and sold his whole interest therein, this time half to Joseph Scott, brazier, of Boston, and half to Samuel Grant, "upholder" (promoter?), also of Boston, making the sales in 1735 and 1736 respectively, and receiving the total sum of only £123, gold, for the entire iron-works. Grant and Scott made additions, and at the time of the next sale, which was of Grant's half-interest, in 1736, to John Merritt, merchant, of Boston, for £168, gold, the works were described as having three fire places, one hammer, and an "ore-yard." Merritt soon bought out Scott for £170, gold, and in 1739 leased the iron works to Thomas and Nicholas Baylis, iron-masters, of Uxbridge, for twenty-one years at £34 per year. The inventory of the works is given in the lease, and it is further described as "all furnished and suitable to make pig-metal into bar-iron." The place was for many years known as "Baylis' Refinery," and was held by Merritt after Baylis' lease expired, from 1760 to 1765, when it was leased to John Heseltine of Uxbridge. After Merritt's death the iron-works was sold by his executor to Col. Ezra Wood of Upton for £450. In 1794 Col. Wood sold two-thirds of the "forge and refinery" to his son-in-law, James Fletcher, and one-third to Paul Whitin, who had married Fletcher's daughter, Betsy, in 1793, and three great-grand-sons of Paul Whitin are to-day large owners in the Whitin Shops, one of them, G. Marston Whitin, being the treasurer and manager, and two others, C. W. Lasell and J. M. Lasell, being among eight stockholders who own the entire $600,000 capitalization of the present company; so that there has been a continuance of the name and business in the same spot for over a century.

The first Paul Whitin was a blacksmith, and soon began as a manufacturer by making hoes and scythes; and, during the suspension of English trade caused by the embargo of 1807-9, other farm-tools were added to the list of Whitin products, which then kept three trip-hammers and a power-driven grind-stone busy.

Paul Whitin, Sr., was a man of affairs, and presently established a cotton mill on the south bank of the Mumford river. This mill had 1,500 spindles, and here Paul Whitin placed one of his sons, John C., first at a very early age as a worker in all departments of cotton manufacture, but very soon, while yet under twenty, as manager. Here this son, John C. Whitin, acquired that intimate knowledge of cotton-mill practice and the requisites of cotton-mill machinery which were, as events proved, to become the foundation of the Whitin Shops business of to day. In 1826 Col. Paul Whitin formed a partnership with his two elder sons, Paul, Jr., and John C., and in 1830 John C. began his long series of valuable improvements in cotton machinery by the invention of the picker. With two lathes,—undoubtedly hand lathes on wooden sheers, as they are said to have been both together worth less than $15,—and the labor of two assistants added to his own, John C. Whitin built his first cotton picker in about a year's time, finishing it in 1831, and securing a patent on it in 1832. Col. Paul Whitin died in 1831, in the sixty-fourth year of his age, and a new firm was formed, consisting of Mrs. Paul Whitin, Sr., Paul Whitin, John C. Whitin, and Charles P. Whitin, which almost immediately became the purchaser of the mill of "The Old Northbridge Manufacturing Company," and in the picker house of this mill, having a floor space 32×40 feet, the manufacture of John C. Whitin's new patent picker was begun. For it there was a steadily-increasing demand, so that for a long term of years most of the pickers used in this country were made at the Whitin Shops.

This success with his first venture in the line of improved cotton machinery led John C. Whitin to continue with a series of inventions in the same line, until now the Whitin Shops produce all of the machinery used in a cotton mill, except roving machinery, mules, and slashers, and the Whitin pay-roll has increased 800 fold,—from the two assistants who aided in the production of the first picker in 1831 to 1,620 names in 1896.

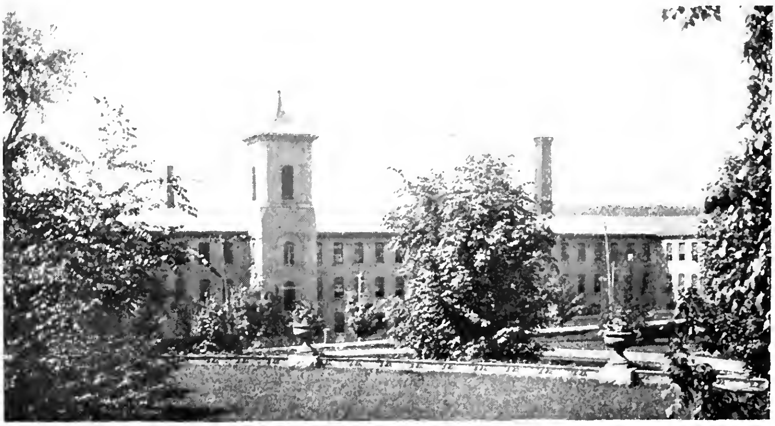
In 1847 the "New Shop," of which an illustration is given, was built, 306 feet long by 102 feet wide, two stories and basement, on the north bank of the river, at the water-edge. This was an enormous establishment for those days; it was equipped with the finest tools procurable, and the possession of this plant gave the Whitin establishment a prestige which it has never lost. In this same year, 1847, James F. Whitin, the youngest son of Col. Paul, was admitted to the firm. In 1860 John C. Whitin bought the Holyoke Machine Works on his own account, which he retained until 1864, when the firm of P. Whitin and Sons was dissolved, and the business of the concern divided, Mr. John C. Whitin taking the manufacture of machinery, and the cotton mills and various outside enterprises going to others. The Whitin shops were immediately increased by the erection of the "New Shop," 475 feet by 70 feet, three stories and basement, parallel to, and just north of, the 1847 structure. A large foundry



THE 1847 SHOPS, FROM THE NORTHEAST.

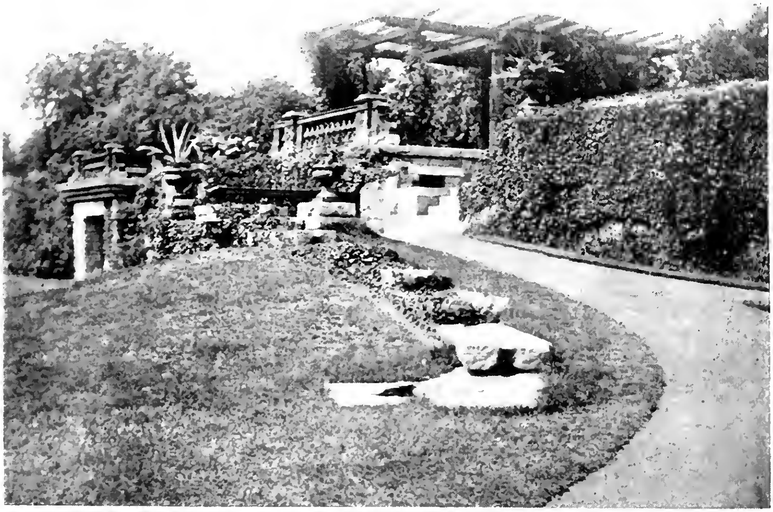
was soon added, and a large smithy, and in 1883 the new shop on the south bank of the river, 386 feet by 86 feet, was built, giving a total floor area of nearly eleven acres in 1889, which has been increased to about sixteen acres at this writing,—September, 1896,—while extensive additions are even now in progress. In 1870 the business was organized as a stock company, with a capital of $600,000, now owned by eight share-holders.

The history of the Whitin concern, as here sketched, gives strong indications of the Whitin characteristics of fair-dealing and consideration of the rights of others, which alone could make the long-continued and amicable association of Col. Paul Whitin and his sons,



THE WHITIN IRON WORKS.

and their sons, and their sons' sons, possible, so that now the fourth generation of the family is in control of the great business which has grown up from the small beginnings in the little iron-works at the falls of Mumford river at the place commonly called Masconsapong. Except in its fierce and uncompromising disapproval of Medford rum and all allied beverages which makes it impossible to alleviate a nineteenth-century normal thirst in Whitinsville of to-day by open purchase, the Whitin character is marked by a spirit of broad toleration in all directions,—a full and generous interpretation of the rights of others, no matter how dependent their position, or how feeble their powers for the maintenance of those rights.



TERRACING ON THE HILL OPPOSITE THE SHOPS.

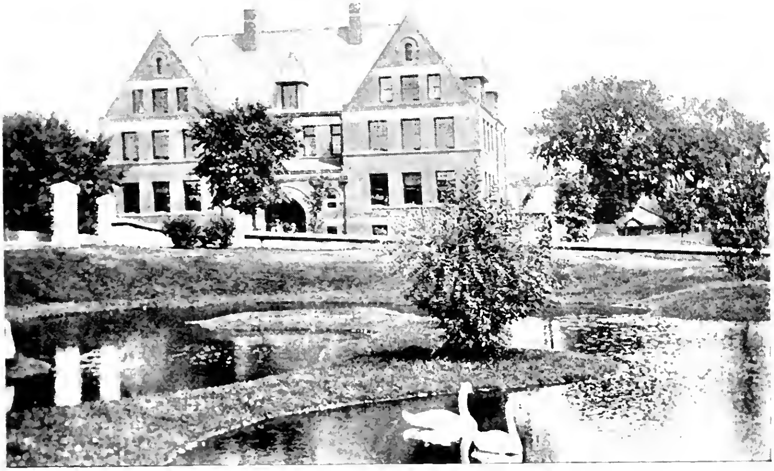
The Whitin Shops are now under the immediate management of Mr. G. Marston Whitin, treasurer of the company, and Mr. Taft, "agent" by title in the works, who fills the office of managing superintendent, as did his father before him, so that for more than thirty years the Tafts, father and son, have had control of the workmen of the Whitin Shops. The one other marked trait of Whitin character is a love of beautiful surroundings, which found expression in the castellated architecture of the 1847 shops, the half-octagon eastern end of the "New Shop" of 1864, fine terracing and landscape effects produced on the south end of the hill, just across the road north of the shops and in full view of the shop windows on that side, and in the streets and public buildings of the town. The natural beauties of Whitinsville were very great, and they have been preserved and added to by irregular streets, ornamental stone retaining walls and bridges, and the preservation of trees, which our simian ancestry makes us ever regard as symbols of home and rest, so that Whitinsville is everywhere pleasing to the eye of the beholder.

After inspection of the works under the guidance of Mr. Taft, a conversation with that gentleman and Mr. G. Marston Whitin brought out the surprising fact that the management of the labor was without even the faintest trace of a defined policy, except that of a full con-

A STREET IN THE WHITIN TENEMENT DISTRICT.

sideration of the effect of any business move on the earnings and peace of mind of the workmen. "We often do not do what we would prefer to do so far as we are concerned, because it would affect our men unfavorably," said Mr. Whitin; "we do not consult our men at all; we know, of course, how they are situated, and what effect any change will have on them, and we let their side of the matter influence us when we can consistently do so."

There is no fixed policy as to piece-work or day-work. A large part of the work is always at piece-rates, but under varying conditions the piece-rate on a certain job may be discontinued and day-prices be substituted. The spindle-forgers, for instance, are now on day-pay,



A SCHOOL BUILDING, FROM THE ORNAMENTAL GROUNDS.

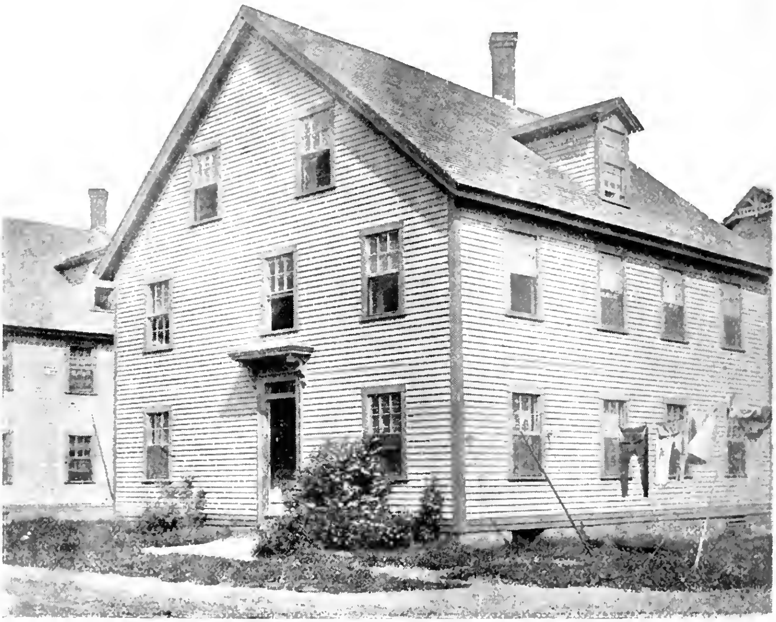
though, if the demand for extreme production was urgent, these hammer-men would be put on piece-rates, which would increase their day-pay and the output together. "When I want more work," said Mr. Taft, "I put the spindle forgers on piece prices: then they fix their fires in their own time, and run their pay up, and get out more work for me; when we are not driven, we put the spindle jobs back on day-pay, and get less work, and may be pay a little less per spindle. I don't know exactly. If the shop is running easy, we go easy on the men; if the shop is crowded, we crowd the men a little, and pay them

MEMORIAL BUILDING, PRESENTED BY THE WHITINS TO THE TOWN.

more money." Mr. Taft smiled when he confessed to this elastic policy, and so did Mr. Whitin.

The Whitin concern owns a very large amount of land, and has about six hundred tenements, usually in the form of double dwellings, rented to employees: the rental varies from $3.50 per month for a five-room tenement to $14 per month for an eight- or ten-room detached cottage. This tenement district extends along the bank of the pond, and rises on the foot of the hill. The location is beautiful, and in many cases the occupants maintain flower-beds; in most cases, however, exterior adornment is neglected. The pond and surrounding hills give a beautiful outlook. The air is pure and cool; the water supply is a gravity system from two large springs of great purity, and belongs to the company. It is the rule for the workmen to marry, and children are abundant, healthy, and happy.

The nearest approach to a strike in the Whitin Shops occurred when the ten-hour law was passed in Massachusetts. The workmen asked for the ten-hour day from the member of the Whitin family at that time in charge, and it was given them, with the information that the works would be fenced in, and provided with locked gates. The

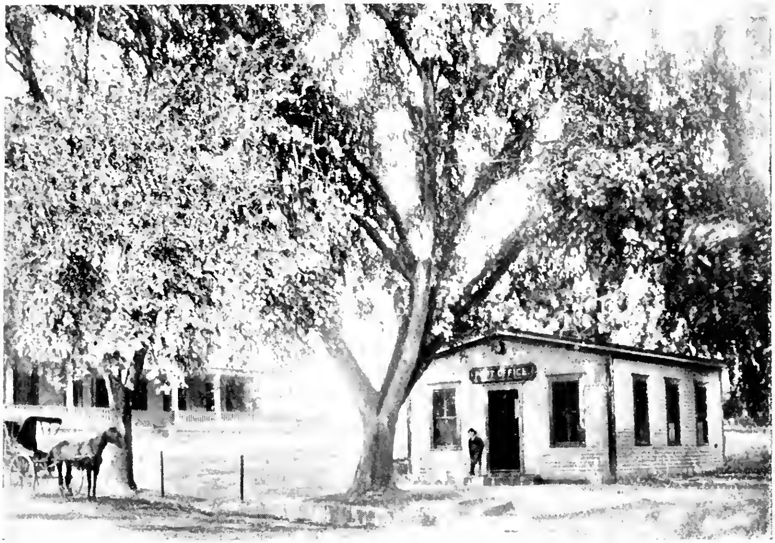


A WHITINSVILLE DOUBLE TENEMENT.

THE TENEMENTS ON TUESDAY MORNING.

THE TENEMENTS FROM ACROSS THE POND.

working-hours had been nominally eleven: if a workman was five or ten minutes late, it was not noticed, and, if a hand wanted a piece of pie in the forenoon, he simply walked out of the shop to his home after it. The mail came to the little post-office across the road from the works at five in the afternoon, and, of course, nothing was more reasonable than that a workman should go over to the office to see if he had any important letters. There are to-day fish in the pond, and fur and feather on the hills about Whitinsville, and in the old days



THE ELM-SHADED POST-OFFICE.

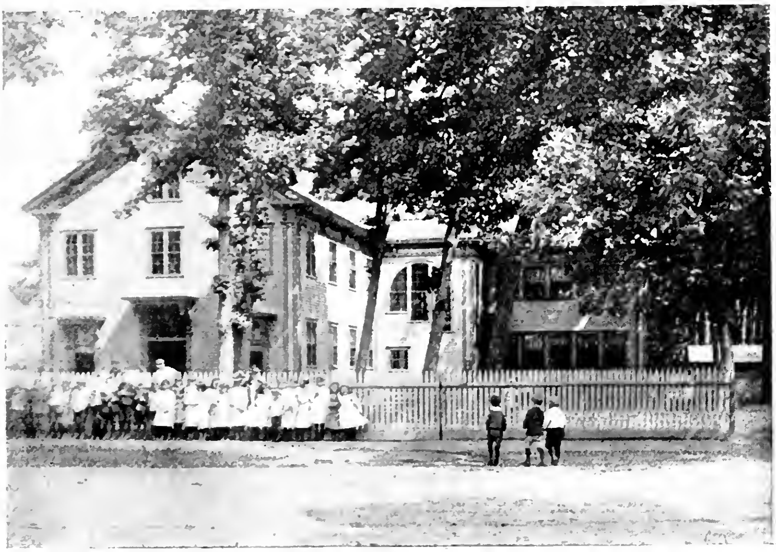
many of the hands took their guns to the shop with them, and a flock of ducks in the pond, or even a musk rat swimming across, was the signal for a sporting expedition. The ten-hour day with the fence and the locked gates made such a change in affairs that some of the old hands were heart-broken and resigned their places, and the management obtained much better results from a day's labor than ever before.

This ten-hour day incident was the only one in the whole time of four generations of Whitin management that caused any hands to leave the shop, and in this case there was not the remotest approach to a strike. The old hands who quit simply could not brook the idea of a locked gate. There has never been any formal recognition of the "rights" of the workmen, and, in point of fact, the Whitin management is simply a despotism, with power to banish any objectionable personage. Whitinsville has five or six thousand inhabitants,—perhaps more. Statistics were unobtainable. The industries are the Whitin Machine Works, Whitinsville Cotton Mill, controlled by Edward and Arthur F. Whitin, Whitinsville Spinning Ring Co., Paul Whitin Mfg. Co., and Linwood Cotton Mill. All of these concerns are controlled by the Whitin family and its branches, and no workman not approved by the Whitin interest could remain in the place. There is no drink sold openly, or to the knowledge of the Whitins. Schools are excellent, $80,000 having been expended on school buildings recently; there is a free night-school for adults, which has from 80 to

100 pupils during the winter months. There are numerous Protestant churches, and a large Roman Catholic church.

The Whitin "Memorial Building," a gift from representatives of the family to the town, contains fine assembly rooms, a well-selected circulating library, a music room, and the needful rooms for the transaction of town business. The Whitinsville Savings Bank has a total of $633,000 deposits, mainly to the credit of the workmen employed in the various manufactories conducted by the Whitin family and its branches. The exact amount of deposits to the credit of the iron-works hands could not be obtained, but it is a large sum. From 1835 to about 1865 the iron works borrowed the savings of its workmen at 6 per cent. compound interest, renewing its notes in April of each year with interest added. This arrangement was closed before the establishment of the savings bank, which pays 4 per cent. on deposits.

There is no theatre in the place. Nor is there an objectionable resort. A few only of the machine works employees own their houses,—perhaps one hundred and fifty all told. Churches, secret societies, Masons, Odd Fellows, Knights of Pythias, the Order of Red Men, the Musical Society of Whitinsville, and cycle clubs furnish the social distractions. The labor at the machine works includes a considerable number of Armenians and some Turks: the Armenians recently demanded the discharge of the Turks, and, when this was refused, about forty of the Armenians left. This was purely a race matter.



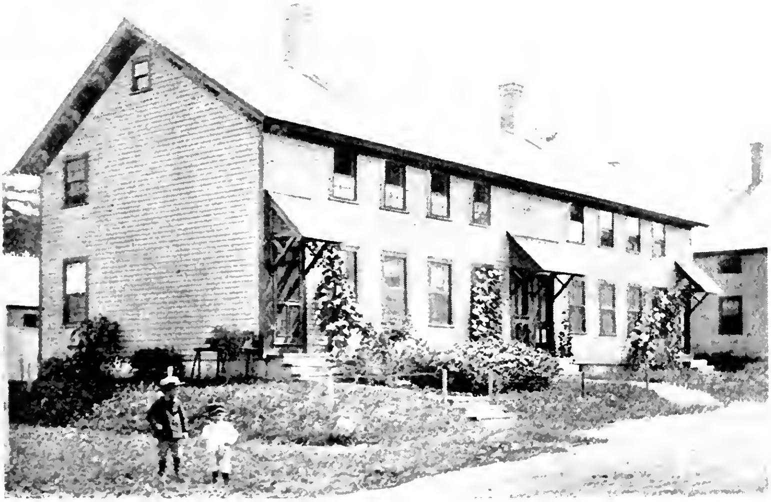
SCHOOL FOR THE WHITIN IRON-WORKS CHILDREN.

The harmony existing between master and man at the Whitin machine works is due to the beautiful and healthful and comfort-giving environment, to the heredity of obedience and confidence transmitted from generation to generation of workers under one management, and the Whitin sense of justice and the employer's duty to protect the defenceless. The workmen are happily situated, their children are robust, and their wives are contented. Wages are low, but rents are low, and there is no car-fare to pay, or drinking-place to rob the workman's family of his earnings: and the work is such that a man must be wholly decrepit before he cannot produce a fair daily output.

WHITIN MANSION, ON THE HILL OPPOSITE THE WORKS.

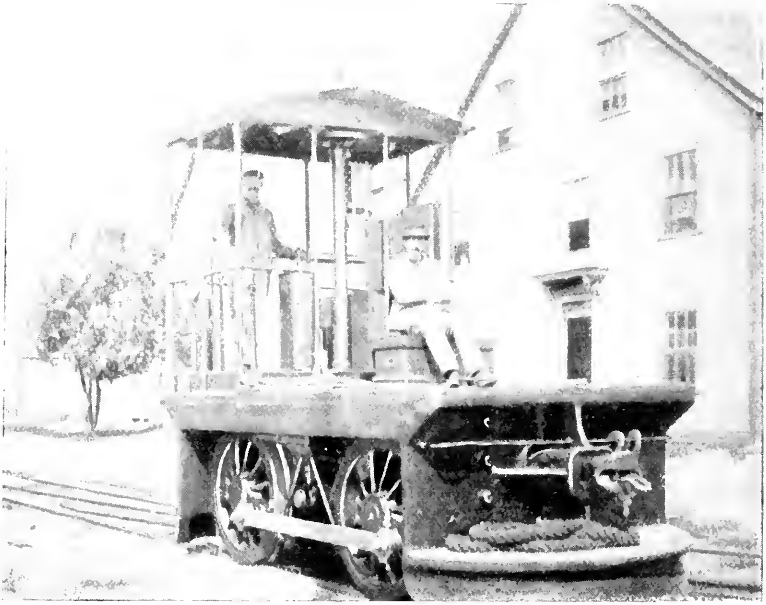
There are over a hundred workmen who have been more than twenty-five years in the shop. The oldest living hand is Sylvester Keith, who began in 1839, at 8s. 6d. per day, or about $1.42. At that time Keith paid $18 a year house rent, and most provisions were cheaper than now; the present average pay for machinists is from $1.65 to $1.70. The high pay-roll was given as $16,000 or $17,000 per week, which would make the grand average for 1,600 hands about $10. Sixty cents a day was given as the low apprentice pay. It is quite the rule for sons to follow the fathers into the shop, and some names appear on the pay-rolls continuously from the first until now.

The whole case may be summed up in saying that the Whitin machine works hands are happily situated, comfortably housed, lightly



AMONG THE WHITIN TENEMENTS.

A GROUP OF WORKMEN'S FAMILIES.



THE WHITIN THOMSON-HOUSTON ELECTRIC LOCOMOTIVE.

THE ELECTRIC ROAD FROM WHITIN TO WHITINSVILLE.

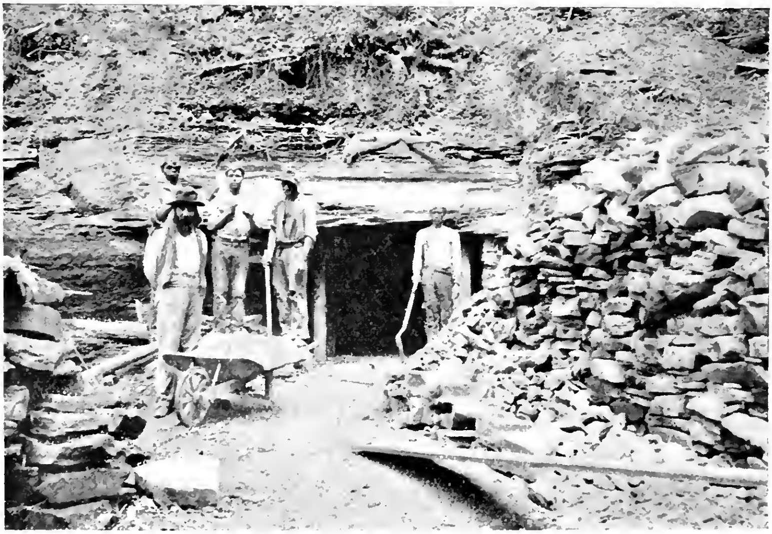
worked, surrounded by beautiful sights, fully occupied with easy labors by day and innocent amusements during their leisure hours. They marry and have children, and their lives are full of the principal possibilities of human enjoyment, and back of all stands the Whitin management as a special providence, considering, first of all, the limitations and the needs of their workmen, in a highly uncommercial manner, which, nevertheless, has led to a sound and persistent commercial success.

The original fifty or sixty horse power of the falls of the Mumford river has been increased by an extended reservoir system to 400 h. p. This is supplemented by 700 h. p. of steam. The floor-acreage is almost continually being extended, and the reputation of the Whitin cotton machinery is of the highest: all of the work produced is as good as the shop knows how to make; improvements in design are constantly produced, and there is a disposition to increase the weight, and to substitute iron for wood in framing, and to replace the light old tools with heavier modern patterns. The shop is a credit to the country, because of its mechanical ability and commercial integrity, and to humanity, because of its unremitting application of the wisdom of its managers to the betterment of the living conditions of its workmen.

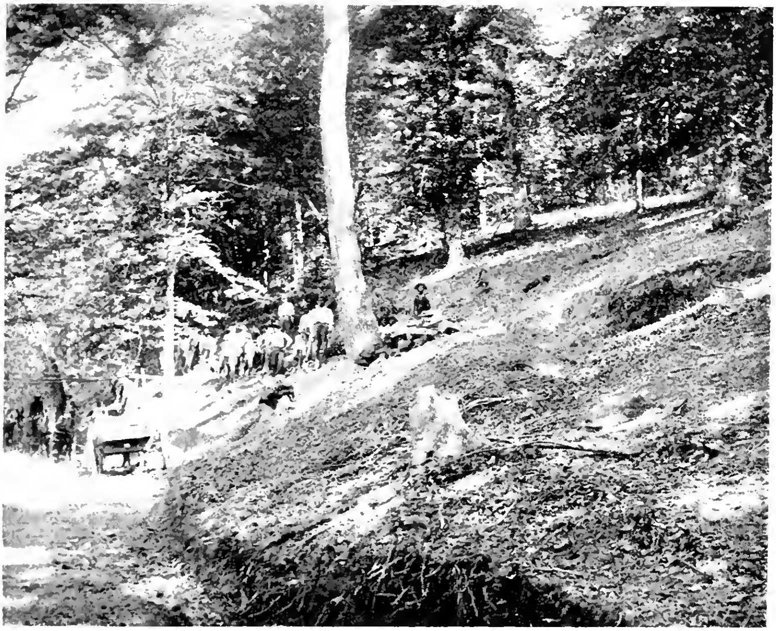
THE PHOSPHATE-ROCK DEPOSITS OF TENNESSEE.

By Lucius P. Brown.

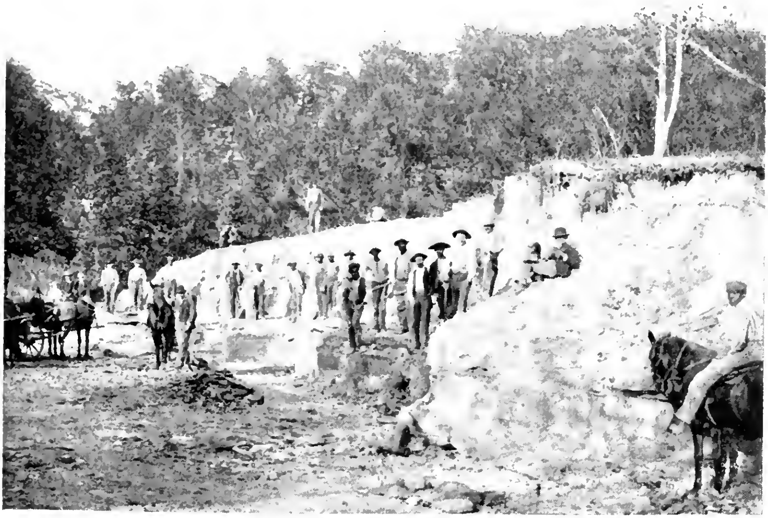
THE very considerable development in phosphate mining in the United States within the past six or seven years, and the attendant enlargement of the manufacture of fertilizers, have probably made any extended reference to their uses and value unnecessary here. Suffice it, then, briefly to mention that the phosphoric-acid-yielding materials (exclusive of bones) that have been, or are now being, worked are of two classes,—*viz.*, mineral phosphates (apatites and phosphorites) having a definite chemical composition and exhibiting the other properties inherent in a true mineral, and phosphate rocks having no fixed and definite chemical composition and lacking the homogeneous nature and definite physical properties of minerals. The former occupy now a comparatively insignificant position, although well adapted to manufacturing, as the cost of mining does not permit them, except for a few special purposes, to enter into competition with rock phosphates in the markets of the world. The supply of the latter is derived from four main fields,—*viz.*, the deposits of Algeria and Tunis, in northern Africa, and the deposits of South Carolina, Florida, and Tennessee. Of these the African deposits are, so



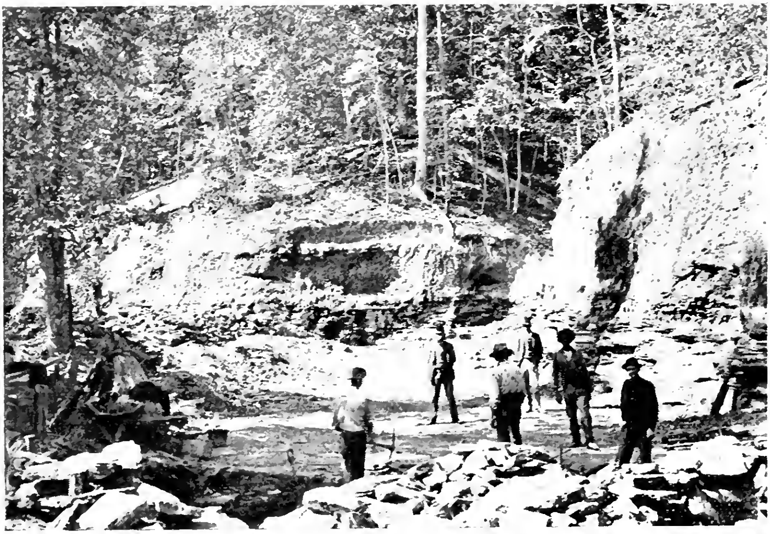
AN ENTRY WAY, TENNESSEE PHOSPHATE MINES.



OPENING A NEW MINE.



THE SIMMONS MINE. STRIPPING JUST REACHING THE VEIN.



A GENERAL VIEW. DUCK RIVER PHOSPHATE COMPANY.

far as mined, of medium or low grade, but are important on account of their proximity to the European markets. The South Carolina rock is of about the same grade, but, on account of the opening of the higher-grade deposits of Florida and Tennessee, this field is no longer so important as formerly. For a long while it was almost the only source of phosphoric acid.

THE OLD PHOSPHATE-ROCK HOUSE.

From whatever field derived, the phosphate rock must, for use, be first ground to an almost impalpable powder, and then mixed with about an equal weight of sulphuric acid. The result of this union is known as "acid phosphate," and contains practically all the phosphoric acid in such a condition as to be soluble in the soilwater (it was before insoluble) and therefore available to the plant. This material forms the basis of all manufactured fertilizers, and is either used alone, or is mixed with materials yielding ammonia and potash, to form complete fertilizers. Finally it may be noted that phosphate rock is usually sold by its content of "bone phosphate," or tribasic phosphate of lime, $Ca_3\ (PO_4)_2$, and, in addition to a certain percentage of this constituent, it must contain not over a certain maximum amount (in the United States usually three per cent.) of the combined oxids of iron and alumina, with a minimum of moisture. The value of the rock, therefore, is, in the trade, always spoken of in terms of bone phosphate, either with or without mentioning percentage of iron and alumina.

Besides those deposits of phosphate-rock in Tennessee which are now being mined, there are some that do not seem to be commercially available, but the title of this article demands that we should give them at least a passing notice. One of these deposits belongs geologically in the Trenton limestones, and is sometimes found lying immediately below the Devonian beds, at other places being separated from them by several feet of Niagara limestones. It is of too low a grade (about forty per cent. bone phosphate) to be of industrial importance, but it, or a cognate formation, has undoubtedly very much to do with the surpassing fertility of the "blue grass country" of Kentucky and Tennessee. The other two deposits lie near the Tennessee river in Perry county, and are of the lower carboniferous age. They have been very well described by Mr. C. Willard Hayes.* One of these consists of a breccia of chert fragments, the matrix of which is phosphatic; the other is a true bedded deposit. Neither of them contains more than forty per cent. of bone phosphate on an average.

The phosphate-rock deposits now worked all lie in Hickman and Lewis counties. These counties lie on what is known as the western "Highland Rim," an elevated region surrounding the great interior basin of Tennessee. The rocks of the basin itself consist of Upper and Lower Silurian limestones; those of the Highland Rim consist of Lower Carboniferous cherts and shales, as the upper rocks of the hills, while lying beneath them are the Devonian and Silurian formations. The region is one of wooded hills, and clear and rapid streams run-

*See Annual Report of United States Geological Survey, "Mineral Resources of United States Non-Metallic Products."

ning through fertile valleys. The hills range from 800 to 1,100 feet in height, and, while the landscapes lack the grandeur of a mountain region, they have, especially in summer, a quiet and peaceful beauty of their own. To the west the Highland Rim slopes with the dip of the strata to the low plateaus and river-bottoms of west Tennessee, which finally end at the Mississippi.

The phosphate deposits belong among the Devonian formations, and are of two kinds,—the nodular and the bedded. They are accompanied by the Chattanooga black shale, which is one of the most widely spread of the geologic formations of the southern states, though usually not of great thickness. Lying beneath this, and often interbedded with it, we find the phosphate stratum, or its representative, while, embedded in a peculiar stratum at the top of the shale, or, sometimes, in the shale itself, we find the nodular phosphates, or "Kidneys." These have been very well described by Dr. Safford, the State geologist of Tennessee. They are "round, oval, kidney-shaped bodies, and are usually more or less flattened." They present a smooth surface, are usually very distinctly of a concretionary structure, contain a considerable proportion of organic matter, which gives them a black or dark gray color, and are an excellent material for the manufacture of acid phosphate, but have nowhere been found in sufficient quantity to justify mining alone, and so are made use of only as they are procured in the mining of the bedded deposit. The latter, so universally known as Tennessee phosphate, is unique in being not a deposit of nodules or pebbles scattered through a clayey or sandy matrix, but a true stratum, in some places as much as fifteen feet thick. It is also the oldest phosphate-rock deposit, in point of geologic age, now worked.

I cannot better describe it than by quoting Dr. Safford's description, written about 1869, as follows: "In addition to the kidneys at the top, the Chattanooga shale has, immediately below it, very generally a dark gray bituminous fetid sandstone, usually fine grained and from a few inches to fifteen feet in thickness. In Wayne, Hardin, and in the southern part of Lewis county this sandstone is often thick enough to be quite conspicuous, forming ledges along the slopes of the hills and sometimes small local plateaus. North and east of Wayne and Lewis the sandstone below the shale is not so thick; in fact, it very often measures but the fraction of a foot."

It will be noted that Dr. Safford refers to this as a sandstone, and such in fact it becomes in the localities mentioned by him, the transition of sandstone into phosphate being so gradual as to escape detection except to one thoroughly acquainted with the latter,—which, indeed, may itself easily be mistaken for a sandstone.

Prof. N. S. Shaler has well said that "there is no substance of equally wide diffusion, among those of considerable commercial importance, which, in the present state of popular knowledge, so readily escapes detection as lime phosphate." This explains how it has happened that all the important phosphate discoveries in the United States have been the result of accident; and this was particularly the case in Tennessee, since the phosphate region has been the scene of much activity by prospectors for iron, oil, etc., and the old "Aetna" furnace in that section is noted in the annals of iron-making in the State. The phosphate rock itself has been often used by builders of chimneys, etc., and in one case a house was built of it by an eccentric farmer. This structure consists of a single room about twenty by thirty feet. It was built by its former owner without help and is said to contain no particle of iron in any shape in its make-up. In view of its singular history and of recent developments, it is a most interesting relic.

While the phosphatic character of the "kidney deposits" has, thanks to Dr. Safford, been known for some years, the true nature of the bedded deposit was not discovered until 1893. In that year two gentlemen living in Linden, Tenn., had conceived the idea that coal ought to be found in this section, and, in the course of their quest, there was sent to them by a Mr. Harder, living near Palestine, Lewis county, some peculiar-looking rocks which he had found while fishing in Swan creek. These samples were sent for analysis to Mr. J. C. Wharton of Nashville, who found the greater portion of them to be black shale, but discovered among the lot a piece of high-grade phosphate rock. Upon receiving his report, the two prospectors went to work to secure options, and others went into the same business. By July, 1894, at which time the first regular shipments went out, three companies had been organized, and now eight or nine are at work.

As mentioned above, the phosphate stratum is nearly or quite as persistent as its companion, the black shale, but those deposits that are rich and thick enough to work have so far been found of limited extent. Only two well-defined fields are now known,—*viz.*, that of Swan creek and Totty's Bend, which form one field, and a smaller one on Leatherwood creek in Hickman county. The extent of the latter is small, and not yet accurately determined; the former is about 20 by 4 or 5 miles in dimensions. Workable rock does not exist wherever rock is found over this area, but occurs usually in beds of 40 or 50 to a 100 or more acres in extent. Estimates of the total quantity "in sight" would at present be little more than guesses, but, as a seam of 20 inches' thickness (which is about the average now worked) contains about 5,400 tons to the acre, a simple calculation will show that there is no immediate danger of an exhaustion of the supply.

The bedded rock may be conveniently divided, in a general way, into two main varieties,—*viz.*, compact or fine-grained, and oolitic. These again may be divided into blue, or blue-black, and gray. These divisions shade into each other, and can not be regarded as absolute, but are in use by the miners as a convenient classification. The blue much exceeds the gray in quantity, and therefore has been regarded as the typical color of Tennessee rock. Oolitic blue rock shows to the eye a coarse granular structure, which, under a hand-glass, is seen to be due to numerous small rounded or flattened grains with glazed surface, and to the shell casts of minute shell-fish of which the most numerous had a spiral shell (Cyclora). This oolitic rock shades by degrees into the compact variety. The latter is usually higher in bone phosphate than the oolitic rock; in other words, the fineness of grain of the rock is in some degree an index to its grade. The blue rock sometimes contains as much as 80 per cent. of bone phosphate with from 1 to 3½ per cent. of iron and alumina.

Its color is apparently due to a considerable proportion of organic matter, and it contains, as mentioned below, some pyrite. Along the outcrop and along the joint-planes in the bed the presence of air and the access of superficial waters has oxidized this pyrite and organic matter, and changed the color of the rock to tints ranging, according to the amount of pyrite originally present, from gray to deep red brown. Blocks are often quarried showing on all the edges this change, but preserving a blue center, which gives a very handsome effect. Rich oolitic gray rock is at present known in only a very limited area. Its oolitic structure is more marked than that of any other rock, in the field, and it contains more shell casts. Analysis shows usually from seventy to seventy five per cent. of bone phosphate with low iron and alumina. At one of the mines this gray rock forms the upper portion of the stratum, the lower consisting of a blue oolitic deposit running about five per cent. lower. This is the only place in the field where this formation occurs, though it is not usual to find a seam the same from top to bottom, there being ordinarily two or three distinct layers, one or more of which, however, are usually thin and therefore unimportant.

The chemical constituents of the Tennessee phosphate rock are practically the same as those of all the other deposits of the world, except that it contains a considerable percentage of pyrite (bi-sulphid of iron). A good deal of discussion has taken place as to the action of this material in the acid phosphate shed, and its effect upon the acid phosphate, but it seems now very well established that, if it has any effect at all, it is not an injurious one. Alumina is present in only small amount, and fluorin is a constant ingredient. A table of analyses, made mostly for commercial purposes, and therefore incomplete, but showing well the general characters of the rock, follows :

ANALYSES OF REPRESENTATIVE MEDIUM AND HIGH-GRADE ROCKS.

CONSTITUENTS.	Oolitic Gray Rock (a)	Compact Gray Rock	Compact Blue Rock.	Compact Blue Rock from another mine	"Kidneys."
Phosphoric Acid.........	33.73	36.21	33.29	(a) 32.67	30.64
"Bone Phosphate" on dry basis.............	73.63	79.77	74.03	(a) 72.23	67.14
Iron Oxid..............	2.06	2.84	2.35	(a) 2.14	3.42
Alumina...............		.41	.90		
Iron Sulphid (Pyrite)....	2.09	None	3.15	(a) 4.52	.43
Carbonic Acid.........	3.54	.....	1.12	1.84	.98
Equivalent to Lime Carbonate.........	8.01	.....	2.55	4.20	.... .48
Moisture.....	.25	1.04	1.96	1.40	.....
Organic Matter..........	1.13	.....	2.44	...	.....
Lime (CaO)...........	47.18	.....	46.67	47.37	.....
Magnesia............. .	.23	.....	.44	....	.....
Sand and Insoluble Matter	2.88	....	4.21	2.22	.....
Calcium Sulphate........	.....	.....	4.88	5.65	.....

a. Average of fifteen samples from same mine.

Tennessee rock has shown itself to be probably the best material yet discovered for the manufacture of acid phosphate. It grinds almost, or quite, as easily as the Florida pebble or South Carolina rock, and dries out quickly after mixing to an easily friable product, which contains a low percentage of insoluble phosphoric acid, and a correspondingly high percentage that is available. It appears to be so firmly fixed in the manufacturer's favor that, other things being equal, he will always give it the preference over other sorts on the market.

In marked distinction to the necessity that prevails in Florida and South Carolina, no expensive plant is required in Tennessee for mining and preparing the rock for market. The problems that confront the miner are essentially the same as those met in working a thin and horizontal seam of coal, allowing for the difference of the material ; or perhaps they more closely resemble those encountered in the mining of a thin seam of Clinton red hematite. Up to the present time, a very large portion of the rock shipped has been won by stripping, but this must necessarily grow less important. Most of the veins mined have a good roof of black slate, but again the miner finds the slate badly decomposed, and he must use a large amount of timber. This will doubtless prove to be one of the chief difficulties that will be met, another being, as mentioned, the thinness of the seam. While the character of the deposit changes, both in thickness and quality, in going any distance (say half a mile or more), the quality in any one mine changes only gradually, though very perceptibly. Hence a careful oversight of the rock mined, and frequent analysis, are advisable, since it may very well happen that the quality of the rock may seriously alter without the change being visible to the naked eye. The thickness of the seam in any mine, while it changes slightly, pinching and expanding again (which is probably usually due to the inequalities of the limestone floor beneath it), is also fairly constant. Mine-drainage gives no trouble, as the seam is approximately horizontal, but the ventilation must be looked after to about the same extent as with a red-ore seam. Tennessee rock, in consequence of its peculiar occurrence, is so free from sandy or clayey impurities that it requires no washing, and no drying except when wet by rain or snow. The usual practice is to break it in a crusher to about a two-inch size, but a great deal of rock is shipped in the lumps in which it comes from the mine. A practice of handling that is to be highly commended is to pass the broken rock through a rotary screen, thus cleaning from adherent clay or sand. Tipple screens, such as are used at coal mines, have much the same effect. The screenings, consisting of the smaller particles of the phosphate, and of the clay and sand, and usually containing not less than sixty per cent. bone phosphate, may then be sold either to the manufacturer or for direct application to the soil. The rock which passes by the screen is thus freed of a considerable proportion of its iron and alumina, and the percentage of bone phosphate is also raised slightly.

The natural difficulties with which the Tennessee miner has had to contend have been insignificant compared with those due to artificial causes, chief of which have been the "hard times" prevailing for the last three years, preventing the obtaining of funds with which to build railroads to the mines, which all lie from two to eight miles from the Centerville Branch of the Nashville, Chattanooga & St. Louis Railway. Only one mine has a road to it; this is a narrow-gage, four miles long. Much the larger part of the rock already shipped out has been hauled in wagons from the mines. The Nashville, Chattanooga & St. Louis railway have now put in a road to the mouth of Swan creek, and the probability is that we shall, before the end of the year, see connection of the mines, not only with this railroad, but with the Louisville & Nashville as well.

The future of this phosphate field seems well assured. The production of phosphate rock in the United States during 1895 was 1,007,773 tons. Of this at least 600,000 tons was used in this country. Now Tennessee practically controls those markets not directly within reach of ocean-going vessels, and has, moreover, markets in the north and northwest that are expanding daily, as the virgin lands in those sections wear out, and the farmers learn the advantages of fertilizers intelligently applied. This being the case, it seems to me well within the bounds of reason to say that Tennessee should, in three or four years, furnish at least two hundred thousand tons of rock per annum, if the proper transportation is furnished. As soon as the short branch railroads now in prospect are built, a very considerable expansion of mining may be looked for, and this industry should take rank among the foremost in the southern States. Fair railroad rates, however, are a prime necessity for this result, and it is to be hoped that the liberal policy already inaugurated by the roads tapping the field will be continued. With an improvement in European prices, it is possible that some effort might be made to establish a demand for the rock abroad, but the domestic market is now, and must always be, that upon which the miners here should mainly depend, and which they should seek to completely supply. The demand from this source promises to take all of their output for some time to come, and it is therefore unlikely that we shall soon endeavor to compete with our Florida brethren in the decidedly unsatisfactory and uncertain European market.

Since the preceding article was written, a discovery of phosphate rock has been made, at the village of Mt. Pleasant, which will undoubtedly change greatly the general aspect of the phosphate business in Tennessee. Mt. Pleasant is situated in the western part of Maury county, some fifty miles south of Nashville, and about twenty miles east of the Swan creek valley. The region surrounding it resembles very closely the well-known "Blue Grass Country" of central Kentucky, except that it is more rolling in contour and more picturesque in its outlines. Agriculturally, it is one of the richest sections of the United States, and has given birth to more than one man noted in the history of the State and nation. It lies on the western edge of the "Interior Basin" of Tennessee, a magnificent expanse of gently-rolling plains and low limestone hills which extends from the foothills of the Cumberland mountains almost to the Tennessee river on the west, and much less broken and rugged than the "Highland Rim" region already mentioned. Traversing the basin at intervals, and imparting to its scenery a picturesque quality which makes it one of the fairest lands that the eye of man ever rested on, are ranges of high, but rounded, hills, either wooded, or, when cleared, clothed to their summits in a growth of short, sweet, nutritious grasses. The rocks of these hills are the Lower Carboniferous and Devonian shales and impure limestones, but the rocks of the basin proper are limestones, almost entirely of Lower Silurian age. The newly-discovered phosphate rock seems to be the result of the concentration of a highly phosphatic limestone, known by Dr. Safford's name of the "Capitol Limestone" (so called because of the fact that the State capitol is built of it), belonging to the Nashville (Cincinnati) group of the Lower Silurian. The concentration of this limestone, containing about fifty per cent. of bone-phosphate, to a phosphate rock containing seventy to eighty per cent. has been effected by leaching by carbonated waters, and probably also by a certain amount of segregation. This process seems to be going on even now, and can be easily observed. The dark blue limestone, much resembling the blue oolitic rock of the Swan creek district, changes first to a light gray, somewhat porous rock, seen as a coating on the limestone, and to a reddish or brownish gray, very porous, and rather soft material, when the change is complete. The beds of phosphate seem to be somewhat irregular in extent, but apparently are usually of fair size. Often they are much cut up by chimneys of unaltered limestone extending up through them. The overburden on the beds seems to be light,—usually only a few feet,—and they themselves range in thickness up to eight or nine feet. The rock does not lie in the beds, as in the Swan creek district, in one or more heavily-bedded layers, but in plates hardly ever more than twelve inches in thickness, or two or three feet in breadth, into which the miner easily makes his way with pick and shovel, without the use of drill or powder. This, of course, cheapens the mining of the rock very greatly. Washing, which *may* be necessary, and drying, which is certainly so, may, however, reduce the advantage which this circumstance gives to this field over the Swan creek district. The chief point in which the field excels the older one is the matter of transportation, as it lies directly upon the Nashville, Florence & Sheffield Railroad, a branch of the Louisville & Nashville system. The rock therefore can be loaded on the cars at the mines, thus eliminating the wagon-haul,—that giant in the path of the Swan creek operators.

Analysis of the Mt. Pleasant rock seems to show that, in the natural condition, and without washing, it runs slightly higher, both in bone phosphate and iron and alumina, than the Devonian rock. An average of forty-nine samples running over 65 per cent. showed 74.14 per cent. of bone phosphate, with a maximum of 81.06 per cent. of bone phosphate, and a minimum of 1.86 per cent. of oxid of iron and alumina. It is as yet too early to say what percentage of iron and alumina can be guaranteed in extended mining operations, but the indications are that these ingredients will not give serious

AN OPEN-CUT MINE, SOUTHWESTERN PHOSPHATE COMPANY.

ROCK PILED BEFORE SHIPPING, SOUTHWESTERN COMPANY'S MINE.

VEIN AND MINED ROCK, TENNESSEE PHOSPHATE COMPANY.

BEGINNING OF AN ENTRY. DUCK RIVER PHOSPHATE COMPANY.

LOADING-PLATFORM AND OFFICE, SWAN CREEK PHOSPHATE COMPANY.

trouble. The rock contains no pyrite, and from two to six or seven per cent. of carbonate of lime. Trial-mixings by manufacturers have given excellent results, the product being of a gray color, quickly drying and with a good percentage of "available" phosphoric acid.

While the effect of this discovery on the phosphate industry in Tennessee will be—nay, has already been—very great, it is at present impossible to say in what way this will further manifest itself. Experience in other fields would point to the establishment of factories at points adjacent to the fields where favorable transportation facilities are presented.

A MILL AND CRUSHER. WAGONS WAITING TO LOAD.

FIRST WORKINGS OPENED IN THE MOUNT PLEASANT REGION.

The extent of the Mt. Pleasant field is as yet not accurately known. The Capitol limestone is a widely-disseminated formation in the State, and phosphate rock has already been found at many points outside the Mt. Pleasant district, but so far either too poor in quality, or in too small quantity to admit of mining. It is, however, of course, very possible—indeed, may be said to be probable—that good deposits yet remain for discovery in other sections of the Middle Basin. It is also not at all improbable that like beds will be found in other areas where the Cincinnati limestones exist. It is of interest to note the fact that, except for some rather unimportant deposits mined some years since in Wales, these are the first beds of commercial importance to be found in the Lower Silurian rocks, despite the fact that as long ago as 1888* Prof. N. S. Shaler had pointed out the promising character of this horizon as a field for search for phosphate deposits, and had strongly recommended that it be thoroughly explored.

*Bulletin 46, United States Geological Survey, "The Nature and Origin of Deposits of Phosphate of Lime."

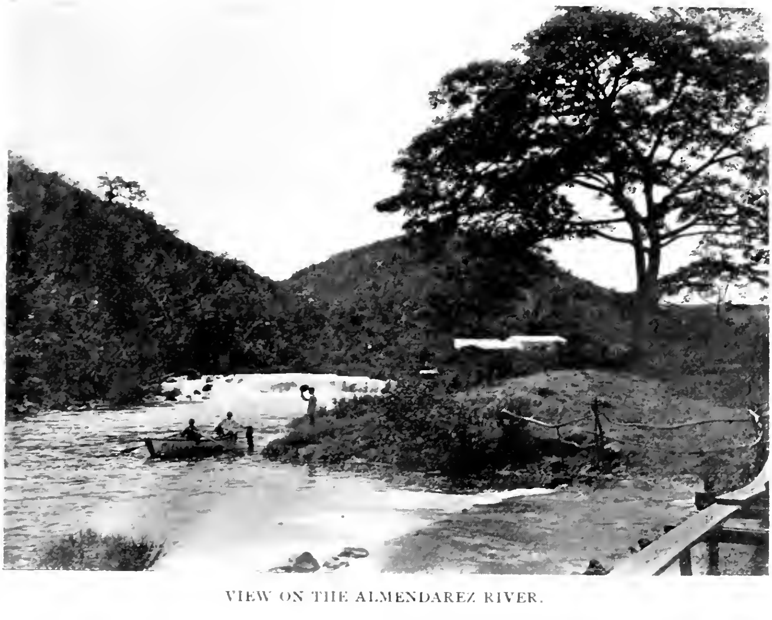
THE WATER-SUPPLY OF A TROPICAL CITY.

By Raimundo Cabrera.

THE island of Cuba, apart from the great sugar plants and a few buildings of classic architecture found in the cities, does not afford many works in which the engineer could find models worthy of admiration and study. But there is one work which claims the attention of natives as well as foreigners, because of its magnitude, tusefulness, solidity, and the wonderful skill exhibited in its construction. Such is the Havana aqueduct, known as the "Canal de Vento."

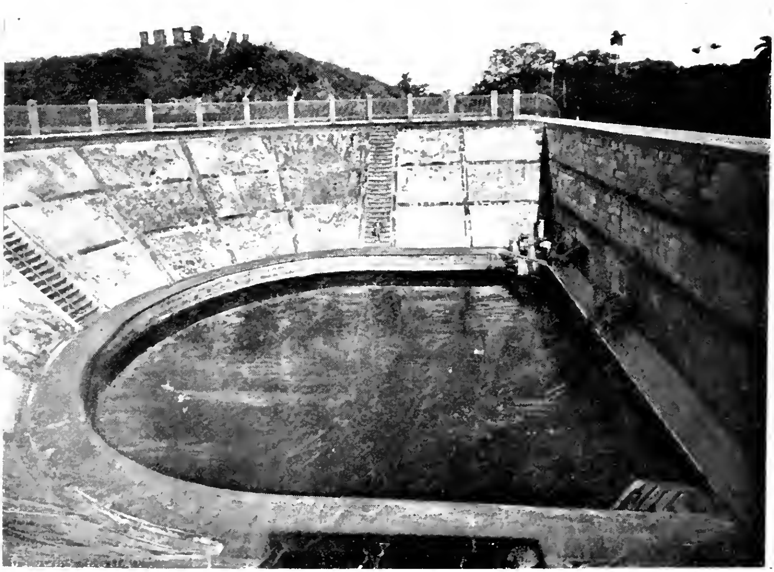
The great number of foreigners who visit Cuba in the winter season, and especially American tourists, never fail to make an excursion to the place where these waters are gathered, and all return impressed by the magnitude of this wonderful piece of hydraulic construction.

In the first century of its foundation, the city of Havana obtained its water-supply from a brook called Luyanó, which empties into its magnificent harbor. The water was brought down by boats, which ascended the stream for a considerable distance in order to secure the water in its purest possible condition; but, with increase of popula-



VIEW ON THE ALMENDAREZ RIVER.

RESERVOIR OF THE OLD HAVANA AQUEDUCT.

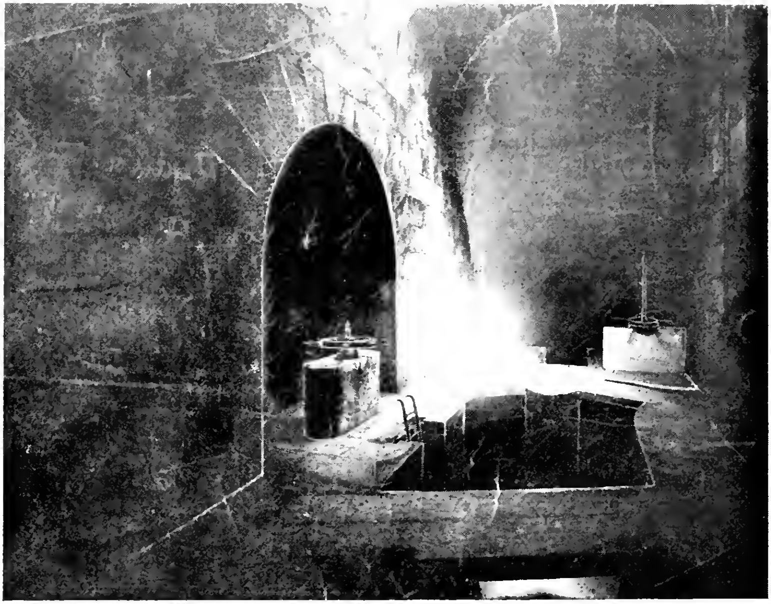


DAM AND RESERVOIR AT SPRING.

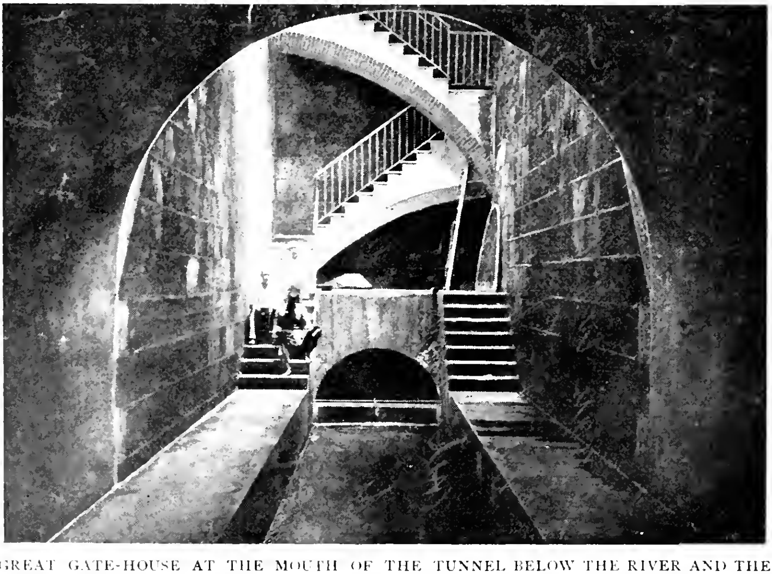
STATUE OF FRANCISCO DE ALBEAR, IN HAVANA.

tion, it became apparent that this system, together with the wells and cisterns then in existence, was not sufficient, and recourse was had to the most common means employed in the old civilization, which consists in bringing the water to the city by means of a channel or artificial conduit from the Almendares river, a distance of more than nine miles. That work was done in 1591, and for two and a half centuries it furnished the only supply of water the population could obtain.

The works consisted of a simple upright dam for the purpose of elevating the surface of the water in the river, and also of a gate at



GREAT GATE TO WITHHOLD OR PERMIT THE WATER OF THE SPRING TO FLOW INTO THE CANAL.



GREAT GATE-HOUSE AT THE MOUTH OF THE TUNNEL BELOW THE RIVER AND THE MOUNTAIN.

the head of the discharged conduit, which is called "El Husillo" or conducting channel. From there the water ran nearly on a level for about 5,000 meters from the dam, at a speed of 0.20 meter per second, furnishing a maximum supply, at the entrance of the channel, of 0.80 cubic meter per second, or 70,000 cubic meters daily, of which, on account of the several drains made for irrigating purposes, not more than 17,500 cubic meters reached the city.

The channel was nothing but a very imperfect conduit of drinking water, generally filthy, and unhealthy on account of the frequent overflows of the swampy brooks encountered in its course; and yet the cost of this primitive aqueduct was $210,961, and the annual expense of keeping it in repair was, on an average, $35,000.

In 1831 was begun the construction of a new aqueduct, intended to take the place of the old and imperfect one, and in 1835 it was completed; it was designed to take the same storage waters from the dams of the Husillo, and conduct them through a reservoir and filtering apparatus, and thence to the city through iron mains. This aqueduct still exists; its cost was $781,679.

The water is drawn from above the dam of the Almendares river through an open conduit of ashlar masonry, with a good gate through which the water passes to the settling basins. These are also uncovered, but not so the filtering tanks which immediately follow them, and into which the water enters, passing to each of the four parts into which they are divided by means of a horizontal percolation through a thin bed or layer of course sand or gravel. The construction of this building is good, and was made regardless of cost. At the north end of the last division is situated the mouth of the conducting main, whence it extends with an internal diameter of eighteen inches until it reaches the city; there the original main was reduced to fourteen inches. The total length of the aqueduct is 7,500 meters, and the fall from the surface of the water on the filters to the main pipe in the city is 22 meters.

Thus the city of Havana obtained the following important advantages as compared with the old system of supply,—*viz.*, economy, greater facility of distribution, and a water freer from impurities; however, no advantage was obtained in the matter of pressure or of quantity and quality of the water. In this second aqueduct the supply was calculated for a future population of a million inhabitants, with a daily supply of 40,000 cubic meters, but the main of 11 inches interior diameter yielded only 3,850 cubic meters daily, which, at the rate of 30 gallons for each inhabitant, provided for only about 38,500 persons,—that is, for a population about two-thirds smaller than that of Havana at that time; and this without taking into consideration the loss of at least one-quarter of the gross supply through leakage and other causes. This defect was partially remedied by substituting for the 11-inch main a main 14 inches in diameter, interior measure; but, on account of the limitation fixed by the established descent, only 5,300 cubic meters daily were obtained, or enough for a population of 53,000. At that time the city of Havana had 150,000 inhabitants and 13,000 houses, so that not more than 2,500 house mains could be furnished to the capital, which, on account of its geographical situation, its magnificent harbor, and its commerce, increased in population to 250,000, besides a floating population of 20,000. It was compelled to remain in this miserable and unhealthy condition until the Vento canal was completed; a long and painful period two-thirds of the population being, so to speak, compelled to live thirsty.

It is a well-established fact that among the questions most closely allied to public order, health, development of wealth, and the physical welfare of the citizen, there are few of such importance and utility as is the abundant supply of pure water. In a city like Havana, where a hot climate is experienced and where the construction and the alignment of the streets are old-fashioned, the matter assumes still greater importance, especially since the city is destined to become a great center, because of its geographical relations to the wealth and commerce of the country.

The projector of the famous Vento aqueduct was Mr. Francisco de Albear y Lara, a native of Cuba, member of the engineer corps of the Spanish army, and otherwise an eminent man, having distinguished himself by his great learning exhibited in the direction and carrying out of many other important engineering works. Among these may be mentioned a system of drainage of swampy lands, and others for the disposal of sewage, which obtained the first prize in the Universal Exposition of Philadelphia; he also obtained a similar medal for the Vento aqueduct at the Amsterdam Exposition.

In a learned pamphlet, an excellent treatise upon the broad subject of city aqueducts, Mr. Albear showed the urgent necessity of furnishing Havana with a perfect supply of water, and proposed to utilize to that end the wonderful Vento springs, which emerge most abundantly from the very banks of the Almendares river, at the foot of the hills called del Barco, a distance of nine miles from the capital. The waters of these springs were formerly lost in the several rivulets and valleys tributary to the river.

In this pamphlet, published in 1856, the necessity for constructing the important work we are about to describe was clearly pointed out to the government. For a distance of about three miles on both banks of the Almendares river, and especially on the left side, there emerge at the base or foot of the mountain a number of springs of varied volume and strength, from the tiniest jet to the mighty stream which, like another river, cuts its path through the heart of the mountains. There was one group which, above all, burst in great abundance from twenty different places within a small space at the foot of the hillside, and, gathering in one compact volume, fell like a cascade of diamonds into the Almendares river, causing its current to swerve to the opposite bank. These waters, always clear, pure, transparent, crystal-like, and palatable, maintain this same temperature in all seasons of the year; that is to say, they are cool in summer and warmer than the air in the cold winter days.

The great volume and force of the outflow led some to suppose that they had their origin in the filtration of the great Ariguanabo pond, or were fed from the San Antonio river, which emerges at the foot of a big ceiba tree; these sources being at a distance of thirty miles from each other, Mr. Albear demonstrated the lack of foundation for these conjectures, giving as his reason the fact that the streams had maintained the same height and rate of discharge ever since their discovery, whereas the pond and the river had diminished in volume many times, occasionally to the extent of becoming almost dry; he believed the springs to have their origin in the American continent, and, in conclusion, he showed the absolute assurance of their never-failing supply, unless there should occur some great upheaval which could affect the existence of the springs.

The quantity of water which the Vento springs produce is such that they could simultaneously supply such cities as New York, Philadelphia, and Chicago, should the proper works to that end be devised.

Its palatability is shown by the following analysis made by the eminent chemist, Dr. José Luis Casaseca.

Substances contained in the water.	grammes per litre.
Carbonate of lime	.1280
Carbonate of magnesia	.0257
Carbonated oxid of iron	.0053
Silicate of iron	.0053
Sulphite of lime	.0277
Chlorid of sodium	.0667
Extractive organic matter	.0050
Total	.2637

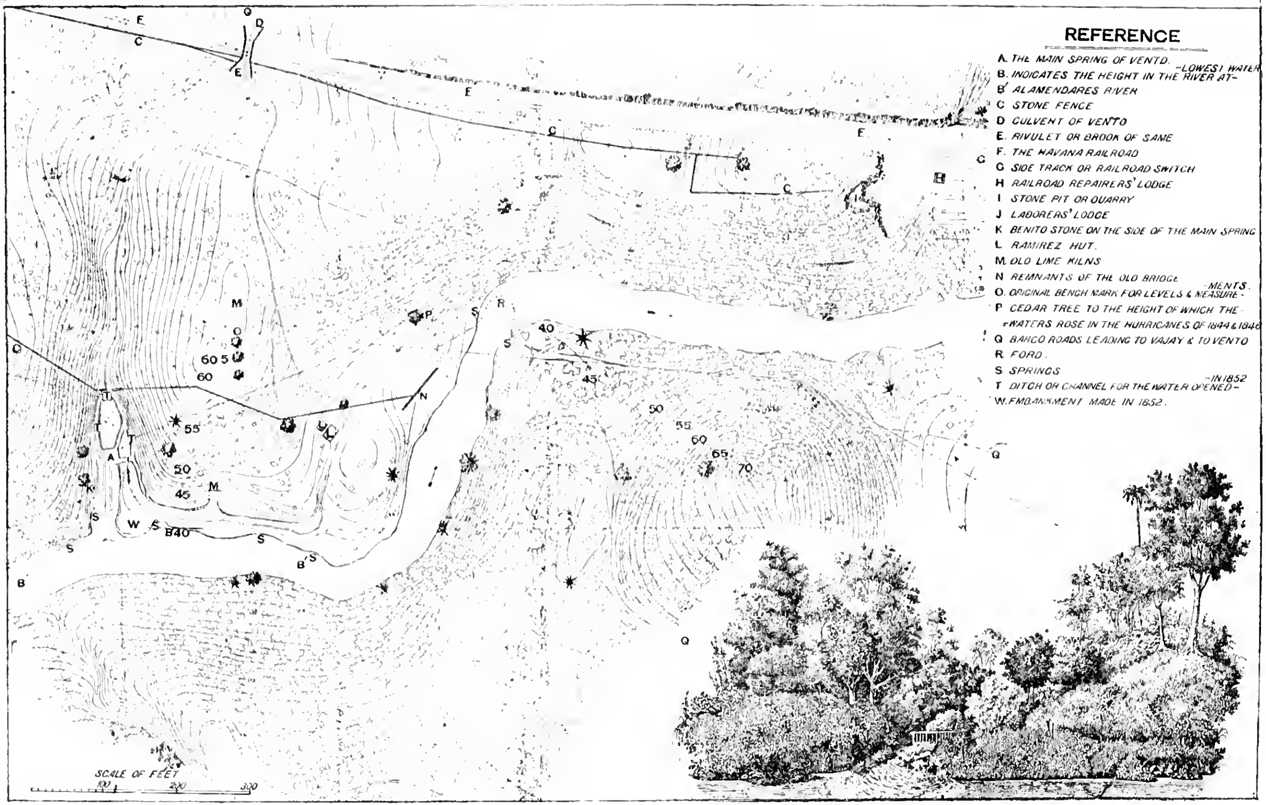
The most important feature of the Vento aqueduct, and that which is of itself enough to have established the reputation of an engineer, is the gathering of the innumerable springs to a common point of storage, the conducting thence of the requisite volume of water to the place of consumption, and discharging the surplus into the river.

This construction presented the greatest difficulty, owing to the topography of the land and the proximity of the river. It seemed as if nature had conspired to place as many obstacles as one could well conceive in the smallest possible space, to render well-nigh impossible the carrying out of an hydraulic work of such magnitude.

The springs are situated at the bottom of a funnel formed by high mountains, and, when the river rises, though ever so little, it becomes equal in height to the springs, and actually covers them completely, the marks of the outpouring of the pure and limpid waters being clearly seen in the midst of the dirty and turbulent waters which flood the main channel at such times. The ordinary discharge channel of the springs itself constituted another inconvenience, because in the rainy season a great torrent descended through it, having no other outlet. The very nature of the ground, being a Jurassic limestone formation, crannied and having innumerable empty spaces through which the water easily escaped as soon as their course was slightly modified, rendered more difficult the execution of the work. Every problem has been solved with the greatest wisdom and professional skill; the water of the spring is gathered in a great ashlar masonry and cement cistern, which forms the bottom of the natural funnel of the hillsides, and is completely isolated from the waters of the river; the *débris* coming from the overflow of the rivulet or brook is directed separately into the main stream. The waters from the springs are elevated to their proper level by simple accumulation, and their conduction to the city is thus rendered easier and more economical.

A great gate or dam closes this storage reservoir, the surplus being discharged by means of underground galleries into the river.

The separation from the waters of the river is effected by means of an elevated dike of sufficient thickness to resist the violence of the floods, which sometimes attain a height of eight meters. It forms one side of the storage basin, and thus serves a double purpose, by holding the spring waters and making them rise to a determined and convenient height, so that they may reach the city by gravity and supply the highest building without the use of any motor. In a word, in the first and most important part of the construction of the aqueduct have been overcome the greatest difficulties of the ground, by lowering the foundations of the dam, the dike, and the retaining walls of the hillsides, until the different streams of surface water are cut off, and all the water of the different springs is gathered in a single uncovered reservoir, protected from the overflowing of the river by means



TOPOGRAPHY OF THE VENTO SPRINGS AND SURROUNDINGS.

of the dam, from the torrents of the brook by a special channel, and from the *débris* of the heavy rains on the hillsides by means of efficient crowning ditches.

The surface overflow is so arranged that the discharge channel terminates in the most convenient place possible in the direction of the river's course, while it is impossible for the back waters from the river to enter the reservoir, even in times of extraordinary floods.

The cost of this part of the work was $280,403. The second part of the work, no less admirable in its execution, is that which relates to the designing of the aqueduct.

The springs are situated on the left bank of the river and the suburbs of the city on the right, the country lying between them for the first 5,000 meters being broken by a succession of hills extending from east to west, bordering the course of the Almendares river and giving rise to innumerable small streams and swampy rivulets.

Far beyond the hills continue, forming a broad basin, in the center of which is a swamp surrounded by high hills in the suburbs of the the city. The land about the spring abounds in fossiliferous lime stone, but its character changes at the foot of the Barco Heights, which, for a distance of more than 2,000 meters, form a bank of stratified sandstones so soft that the heavy rains break them to pieces. Then follow the lands of the swamp, and then the hills near the suburbs in which the lime stone is again to be found.

The first work of the engineer was the question of crossing the river. It could be effected by crossing to the opposite bank immediately at the spring by following down the left bank to a distance beyond the mountains, or by crossing at an intermediate point, near the fork of the road from Barco to Vajay.

The first was deemed inadvisable, inasmuch as there was little room for the necessary gate-houses and other works, and the excavation would weaken the narrow strip of land separating the springs from the river channel; the second involved topographical difficulties, and would bring the aqueduct in dangerous proximity to the railroad and its attendant tremor of the ground.

In order to accomplish the third and adopted scheme, the engineer considered three plans: first, to construct a bridge of seven segmental arches, the center arch having an opening of 15 meters and the side arches respectively 12½, 10, and 7½ meters, which would receive a syphon, the upper part of which would not be above the level permitted by the limitations of the atmospheric pressure in raising the water; second, to place in the bottom of the river inverted syphons (a construction, however, which does not afford the desired safety for a Cuban city aqueduct, because of the impossibility of superintending and repairing it with ease and promptness); third, the construction of a tunnel under the river and the hill on the oppositeside.

This last, though somewhat more expensive, was the plan adopted, on account of its many and great advantages, and carried out with skill and success. In this manner were laid with absolute safety the pipes of the syphon, thus facilitating the inspection, repairing and renewing of the parts as required.

The tunnel may be easily entered by means of broad and commodious stairs; the walls and vaults do not show the least trace of humidity, this being the feature which excites the greatest admiration of all visitors, especially when the employees permit them to view the operation of opening and closing the gates and to see the current flowing from the springs and pouring like a cataract, at the mouth of the syphon where the channel proper commences.

The excavation measures 4,258 cubic meters; the vault is made of brick masonry and hydraulic mortar, its total cost being estimated at $372,466, including the gate-houses, valves, and machinery situated at both entrances of the tunnel.

The aqueduct proper commences at the tunnel, and is laid out in straight stretches alternating with curves in arcs of circle, the radius of which is never less than 200 meters, whereby the bends are eased and reduction of flow and the speed avoided. All the topographical difficulties have been admirably overcome in the plan adopted, and a great ultimate economy has been achieved in the construction.

The total length of the line from the Vento springs to Jesus del Monte, in the suburbs of Havana, is 10,800 meters.

The masonry aqueduct was decided upon, in preference to other means of conduction, because iron pipes would both be more expensive (for an equal volume of flow) and occasion greater loss of head and greater maintenance expense, while an open canal would not so well conserve the purity and freshness of the water, and would, moreover, involve considerable loss from evaporation.

The conduit proper is one meter in depth and two in breadth; the bottom is an inverted arch, with a rise of one-tenth of a meter, and a thickness of one-half meter; the sides have an outward slope, on the inner face, of ten centimeters per meter, being .75 meter thick at the bottom and .65 at the top.

The conduit is covered by a circular arch, with an internal radius of one meter and an external radius of one and four-tenths meters, brought down with uniform thickness to the spandrils and thence extended by tangent planes to the exterior of the side-walls.

The aqueduct has a uniform slope of .0003 per meter, or one in 3333. This gives the water a flow of .6 meter per second, and the consequent supply delivered is 72 cubic meters per hour, or 103.680 cubic meters (about 27,500,000 gallons) per day.

The method of construction avoids any necessity for frequent repairs or alterations ; the water is not exposed to loss by evaporation, but is in sufficiently free contact with air through the ventilation afforded by ventilating and observing towers, constructed at proper intervals, through which also any needed access may be had for inspection or examination.

This part of the work was estimated at $1,280,853, and both the aqueduct and works at Vento were devised and constructed under the direction of the engineer, Albear y Lara, who did not, however, enjoy the satisfaction of seeing them finished.

Later on, and under the superintendence of another engineer, Joaquin Ruiz, and a North American construction company, the grand reservoir was built, description of which is omitted, as its form and system are similar to those generally established in this country.

The construction of the aqueduct described above was a work of many years. It was projected in 1856, but not commenced until 1860 ; the penurious disposition of the administration was the cause of many interruptions. Albear, nevertheless, had the good luck to see coming to the city a part of the waters from the springs that had been imprisoned by connecting the canal through a temporary connection to the iron pipes of the old aqueduct, and only five years ago the city of Havana began to enjoy the incalculable benefits of this magnificent work, the total cost of which has reached the sum of $6,000,000,—owing wholly to the stoppages and interruptions encountered in its construction, for lack of funds, and the mistakes of the administration, and in no wise to any error of the builder, who made his projects, estimates, and plans with the strictest accuracy. Even at this very day the work of the canal, of the reservoir, and of the distribution apparatus, finished as they are in every detail, do not give the results which might be expected, because the setting of new and larger pipes has not been completed. Those of the old San Fernando aqueduct, which were laid from 1835 to 1855, are utilized, many of them having been used for sixty years and lacking the necessary diameter. The pressure of the water destroys them easily, leaks are plentiful, and the supply and head are thus diminished.

The name of Albear, to whose talents and labor the realization of the project is due, will be honored as long as the aqueduct exists, as one of the most illustrious benefactors of the community. A marble statue erected to his memory on Monserrate square, at the very center of the city, bears witness to the gratitude of the people.

THE POSSIBLE AND THE IMPOSSIBLE IN ELECTRIC DEVELOPMENT.

By Wm. Baxter, Jr.

IT is very generally believed by laymen that our knowledge of electrical science is so meager that we are wholly at sea as to what the development of the future may be. So strong is this conviction that any assertion as to the possibility of accomplishing the most unheard-of things is accepted as strictly within the bounds of reason. Nothing, however, could be further from the truth than such notions, for, as a matter of fact, we are no more in the dark in respect to electrical science than to any other. We cannot say that we have mastered the subject from A to Z, nor could such a claim be substantiated in any department of science. We can truthfully say, however, that the electric field is as far advanced as any other.

There are a great many things possible that have not yielded to the efforts to reduce them to a practical form, and there are a great many other things supposed, by the uninformed, to be possible that never will be reduced to the practical form, simply because they are impossibilities. The knowledge we now possess of science in general enables us to separate the attainable from the unattainable, in the theoretical sense; but we cannot make such a classification as to practical results with the same degree of accuracy, owing to the fact that we cannot judge with certainty as to the possibility of overcoming obstacles not yet encountered. In consequence, we are able to decide with certainty only as to what is impossible, and therefore can never be accomplished; as to the possibilities we can only say that they are such theoretically, but practically may be beyond realization, on account of our inability to remove obstacles.

This statement may appear inconsistent to those in the habit of considering that a result can or cannot be accomplished, but a little reflection will show that so complete a process of differentiation can be applied only in a limited number of cases. For example, we can say without hesitation that a man cannot jump over the Hudson river, since the act is a physical impossibility, implying a controversion of the laws of nature; but we cannot speak with the same certainty with regard to an effort to fly across. We know that there is no theoretical barrier in the way of accomplishing this result, but we also know that the practical difficulties are very great, and have not been overcome; whether they ever will be is a matter of pure conjecture.

A positive knowledge of what can be accomplished in the future would be of the greatest value, as it would enable us to shape our actions accordingly; but, this degree of certainty not being within our reach, an approximation to it may be regarded as desirable. An investigation that will determine just where we stand may serve to show that in reality we are very nearly as well off as we would be if all uncertainty were removed.

Since the impossibilities can be pointed out with certainty, it will be well to consider them first,—especially as it is in relation to these that the most absurd notions prevail, the greatest number of impractical schemes being brought forward to captivate the too confiding investor.

It is not an uncommon thing to hear of some one who has invented a simple mechanical contrivance whereby the light obtainable from a given amount of electric energy can be doubled; or of an electric motor that will greatly increase the output; or of a generator that can furnish current for several times the number of lights now obtainable from the same engine-capacity. The power-station of electric railways has several times been threatened with extinction by inventions in which it was proposed to mount a dynamo on one axle of the car and a motor on the other, the former to be rotated by the motion of the car and thus furnish current to operate the latter, the car being driven by the power thus developed. As it is evident that the dynamo would not generate a current until set in motion, and that the motor would not give any power until supplied with current, and the car would not move of its own accord, the difficulty of starting has, in almost every case, been provided for by adding a small storage battery to furnish the starting current, the latter being recharged by the dynamos when the car is in motion. To the engineer all these schemes look so absurd that it is almost impossible to believe that they can be considered as anything more than a huge joke, but, as a matter of fact, they are regarded seriously by many capitalists. Their inventors are, in most cases, unprincipled charlatans, who live by foisting fraudulent schemes upon the public; but in some instances the inventors are the victims of their own ignorance.

If science were in as crude a state as it was at the beginning of the century, we might not be able to determine with certainty whether such devices are possible or not, but our knowledge of the laws of nature at the present time is such that there is no room for doubt. To put the matter plainly, we know that, when we transform electric energy into mechanical, nothing is gained or lost by the operation, and the same is true of the reverse process. We know this, because we can measure energy, in its various forms, just as easily as the grocer can weigh a pound of lard, and with far greater accuracy. Those who honestly believe that they can discover some way whereby a motor may be made to drive a dynamo and the latter to furnish current for the former, and a surplus to use for lighting and other purposes, may be surprised to learn that this arrangement of machines is used for the purpose of testing their efficiency, by many manufacturers, and that the amount of extra current that has to be supplied from an external source to keep the combination in motion serves as a measure of the efficiency of the machines. When two machines of the same design and size are connected so that one acts as a generator and the other as a motor, the demand of the latter for current is greater than the former can supply, and the difference, which must be provided from an independent source, will vary with the efficiency, but will always be a considerable quantity. To wipe out this deficiency and replace it by a surplus is simply beyond the limits of physical possibility.

Electrical machinery has not been developed to such a state of perfection as to justify the assertion that motors and generators, as mechanical structures, cannot be improved upon. It cannot be doubted that in the future many weak points of the present designs will be eliminated. But the room for improvement in these machines, as transformers of energy, is so small that it is actually unworthy of consideration. For every ten units of mechanical energy we put into a generator we can recover nine or nine and a quarter of electric energy, and, conversely, for every ten units of electrical energy put into a motor we can get nine, or a little more, of work. Inasmuch as the total loss is not over ten per cent., it follows that those who expect the future to bring great, or even noticeable, improvements in this line will be doomed to disappointment.

When we pass from machinery to other branches of the electrical industry, we at once step into a field of uncertainty, not as to theoretical possibilities, but as to practical results. As an illustration, take the storage battery. There are many men who expect that great results will be accomplished in this direction, and that they may come at any time. In theory these views are justifiable, although there may be a considerable difference of opinion as to the actual value of even the best theoretical attainments ; how near to perfection we may arrive in the future it is impossible to predict. The room for improvement in this field is undoubtedly very great, as it is wholly within the limits of theoretical possibilities for the weight of the batteries to be reduced to a small portion of what it is to-day ; furthermore, there appears to be no reason why the durability should not be increased. The actual weight of the material that takes part in the chemical action upon which the storage battery depends is about twelve pounds per h. p. hour of energy stored, and this is about one-tenth of the weight of the batteries now made. As the cell and the frames that hold the active material must weigh something, it is not possible to reduce the weight to the theoretical limits; but this point can be approached, and it would not seem unreasonable to assume that a reduction to twenty-five or thirty pounds per h.-p. hour will eventually be accomplished. This alone, however, would not necessarily be an improvement, because the internal resistance might be so great as to render it necessary to work the battery at a very low rate of discharge, so as to obtain a fair efficiency. The reduction of weight would be a valuable improvement to the storage battery, as it would make its use possible in many kinds of traction work; but lightness with respect to storage capacity would not mean a reduction of the weight of batteries that would be required to operate a car or vehicle, unless accompanied with a high discharge rate. If the discharge rate were low, as it would be with high internal resistance, a large number of cells would have to be carried, and the only advantage derived would be that a greater distance could be covered with one charge. For all classes of stationary work, the most important point is the durability, and, when improvement in this direction has been carried far enough, the storage battery will become very useful; but, for it to obtain a foothold in other fields, where the energy of the battery must be used in part to transport its own weight, improvements must be made, not only in durability, but also in the size and weight. We know that such improvements are possible, in theory, but who can say that they are in practice? Therefore, who can say that the storage battery will, or will not, be perfected to such an extent that it will be used for other than stationary purposes? There are many who have a very strong conviction that it will, but only time can tell whether the ingenuity of man will be able to overcome the obstacles. If they should be removed, the horseless-carriage problem would at once be solved, and the sphere of usefulness of the storage battery would be largely increased.

Of all the great achievements that electricity is supposed to have in store for the future, the perfect primary battery is generally regarded as the most important. So much has been said about the direct production of electricity from coal that every one is more or less familiar with the subject, and the belief commonly entertained is that the solution of this problem would send the steam engine into the scrap-heap, and completely revolutionize the industrial affairs of the world.

If a coal-consuming battery could be made that would come up to the ideal of those who dream about its possibilities, it, no doubt, would accomplish this result; but the actual results of the future, if any are ever realized, may be very different from these dreams. We know that the chemical action between carbon and oxygen will liberate energy, and therefore, so far as this action alone is concerned, we can say that the coal battery is a theoretical possibility ; but the efforts that have been made to overcome the difficulties that beset the problem have so far failed. In order to be able to obtain electric energy from any chemical reaction, it is necessary that the heat set free shall be more than that absorbed, or, in other words, the thermo-chemical reaction must be positive ; with carbon this condition can be fulfilled, but, in addition to this, it is also necessary that the materials used be conductors of electricity. While coal can meet the first requirement, it fails in regard to the second,—that is, it is not a conductor ; hence, before it can be made operative, it must be so changed that it will admit of the free passage of an electric current ; else the chemical action must be brought about by some indirect process. We, therefore, see that, in the very start, we meet a formidable stumbling-block. This, however, is not the only one, and perhaps not the most formidable one. In all the batteries with which we are familiar the active material forms a part of the apparatus, and is destroyed by the process of generating the current. This can be tolerated in the small batteries of the present time, because the work they do is almost insignificant, and therefore the expense occasioned by the destruction of a part is not an important item ; but this would not be the case with an apparatus intended to compete with a steam engine and boiler. To consume the coal part of the battery and be compelled to renew it continually would be about equivalent to making the grates of a boiler of coal, and replacing them as fast as they burned up.

Unless the battery can be made so that the coal can be fed into it as it is into a boiler, it seems that the prospects of obtaining energy at a low cost in this way are not very great. This point was very ably presented by Mr. C. J. Reed, in a series of articles contributed to the electrical journals a short time ago.

Should all the foregoing difficulties be overcome, the value of the battery would depend upon its form. If compact and light, it would be of the greatest value, but, if large in proportion to the output, it would find only a limited application. If light and compact, it could be used to operate locomotives, and thus do away with the power-stations, trolley lines, and feeders. It could also be used to propel boats of every kind, and to furnish power in all cases where the steam engine is now used ; and, as the conversion of chemical energy into work, through the electrical channel, can be effected with greater efficiency than through the thermic chain, owing to the inevitable losses in the latter, it would naturally follow that the electric motor would replace the steam engine for all purposes. If, however, the battery could not be reduced to a light and compact form, the best it could do would be to replace the stationary steam engines, and, therefore, its sphere of usefulness would be greatly reduced.

Thus we see that, while the solution of the primary battery problem is theoretically possible, we are unable to say that it is practically so; nor can we determine what its value would be, owing to the uncertainty as to the form of the solution.

For several years the problem of producing light without heat has received considerable attention, and the work of some of those who are engaged in that field has come prominently before the public during the past few months. This is another of those theoretical possibilities about which we can make no positive predictions. In all the various processes by which we now obtain light, the greater portion of the energy used for the purpose is converted into heat, and, therefore, lost. As energy in its different forms is transformable, and as in other transformations we recover a far greater percentage than in the case of light, there seems to be no reason why far better results should not be obtained in the latter field. The margin for improvement is very great; in fact, the best we can do, now, is to convert about eight or ten per cent. of the applied energy into light, this result being obtained in the electric arc light. In the incandescent light we can recover only about two per cent., and in gas light still less. In view of these facts, it cannot be regarded as unreasonable to believe that better results will be accomplished in this direction; but the progress of the past does not justify the assumption that these results will be realized in the very near future, and, further, we cannot say that, when realized, they will be of practical value, for it may be that the mechanism required to operate the lights will be so complicated or frail as to offset all the advantages.

A review of all the points here presented will show that the line of demarcation between that which we know to be possible and that about which there is uncertainty is not very far in advance of the actual accomplishments. From this it might be inferred by many that we can speak with certainty only about that which has been done, and that, as regards anything beyond, we are wholly at sea. This, however, is not so; we are not at all in the dark as to the theoretical aspect of any case that still baffles our ingenuity, but, having failed to remove the difficulties that stand in the way of the solution of these problems, we are not in a position to say that we know whether they will be removed in the future.

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Gas World, The. *w.* 13s. London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8d. London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4d. London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6d. London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8d. London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8s. London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6d. London.
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technograph. *yr.* 50 cts. Urbana, Ill
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

Building-Stones.

THE importance of carefully testing the durability of building-stone before deciding upon its use is well exemplified in the United States by the present condition of many buildings not yet more than half a century old,—some of them not even fifty years old. The *Bulletin of the Pennsylvania State College* has recently taken up this subject, and has shown that mere strength is not, of itself, an evidence of durability in a building-stone. *The Architect and Contract Reporter* (Aug. 7), reprinting the article from the first-named publication, coincides with this view. No quality of beauty, ease in working, or other desirable characteristic in a building-stone can compensate for lack of lasting quality. The climate of the United States is in many parts very severe in its effects upon some kinds of stone that will last for centuries in milder climes. Thus the obelisk in Central Park has probably suffered more during the short time since it was placed there than during a couple of centuries on the dry, warm Egyptian plain from which it was brought.

Now, the weathering quality of different kinds of stone, or of different specimens of the same kind of stone, can in many cases be known only by careful testing. The article here reviewed says truly that "no rule can be announced other than that suggested by a knowledge of the chemical solubility of the several rock elements. Feldspar is readily transformed into various products of decomposition, and hence is an undesirable element of building stone. Orthoclase weathers less readily than oligolase. Quartz is wholly unaffected by weathering agencies. Sandstone and quartz conglomerates cemented by silicious material are not rapidly disintegrated. The only sure test of the comparative durability of a stone is afforded by its appearance *in situ*. A rock which at the quarry stands out in relief as a conspicuous feature of the country, and whose edges are sharp and true, will furnish good durable stone. Particularly is this true if the rock masses, weather-beaten and fire-swept for ages, still show fresh faces. A stone of hard, close, fine-grained texture and impervious to moisture has a comparatively long endurance. Basalt is the most obdurate to atmospheric influences. One of the best indications of the durability of stones is afforded in the porosity of the stone as measured by the amount of water absorbed by it after immersion for twenty-four hours."

Weighing will easily show the amount of absorption, if the weight before immersion be known. Percentages of absorption for different kinds of stone are stated:

PER CENT. OF ABSORPTION.

	Maximum.	Minimum.	Average.
Granites	0.66	0	0.13
Marbles	0.66	0	0.33
Limestones	5.0	0.20	2 63
Sandstones. ...	6.66	0.41	4.16
Bricks	25.0	2.0	10.0

After stone has absorbed water, frost has a powerful disintegrating action upon it, through the expansion of the contained water in freezing; this action is more pronounced with stones containing soluble substances. Such stones exfoliate; laminar stones split, the freezing water acting like a powerful wedge. The testing of stone is thus described:

"The action of frost may be imitated by the expansive action of a crystallizing substance. A specimen of known weight is immersed in a boiling concentrated solution of sulphate of soda for thirty minutes; it is carefully withdrawn and suspended in a cool, dry place over a dish of the solution. An efflorescence soon appears, when the dish is again brought up to redip the specimen. An exfoliation again appears as the solidifying salt breaks off some material from the faces. After repeating the process during a week's time, the sediment is weighed and computed as an indication of the like effect of frost. A porous stone which absorbs a great deal of the salt secretes a great bulk of solution, and, unless it possesses strong adhering qualities, will yield to the expansive action of the crystallization in like manner as to the destructive action of frost.

"By this means it has been discovered that the life of common brown stones varies from 5 to 25 years; of fine brown stones, from 15 to 40 years; of compact sandstones, from 100 to 250 years; of common limestones, from 40 to 200 years; of marbles, from 60 to 500 years; of granites, from 75 to 600 years; of gneiss, from 100 years to many centuries.

"As an example, by immersion the stone selected for the capitol at Washington was found to produce an amount of sediment after fifty dips, and an inch cube lost 0.315 ounces of its weight. From these data it was estimated that natural freezing would exfoliate this particular stone to a depth of 1 inch in 10,000 years."

Chemical and physical causes, other than weight supported, are the more important factors in the failure of building-stones. Very few kinds of stone in buildings are destroyed by crushing, if their weathering qualities are good.

Art-Smithing in Germany.

IN art-smithing (according to *The British Architect*, Aug. 14) Germany affords a field of study unlike that found in any other country. In the thirteenth century Germany began to develop characteristic features in art metal-working. The divergence from previous styles consisted in "elegant branching strap-work, ending in little *fleur-de-lis* and vine leaves," which, though a French style, yet showed a marked variation from the French treatment. This divergence became more and more pronounced during the next two centuries, "resulting in rich and characteristic foliated ornament based on the vine, mingled with *fleur-de-lis* and tracery forms." In an introduction to the English edition of Professor Charles Sales Meyer's "Handbook of Art-Smithing," Mr. B. T. Batsford sets forth the facts above stated, and adds that in the fifteenth century, at Cologne, a new style of work appeared based on the thistle. This new style "held the field until supplanted by the renaissance ornament."

Mr. Batsford says that "of designers of ironwork, as designers, there were probably none, the master smith setting the task and directing the work on strictly traditional lines, with such modifications only as the moment suggested. The work may, in most cases, have been produced without drawings, for ironwork designs followed certain definite lines of precedent, which might be modified within limits, but were not departed from. Thus grilles were often worked from a center of more or less complexity, with the loose ends of bars finishing in traditional floriated ornament. Progress was mainly, if not wholly, confined to increasing the technical difficulties to be overcome by the smith. Not an illustration or drawing of any scrap of blacksmith's work, drawn for its own sake, has come down to us,—a fact most remarkable in an age so prolific in studies and designs for the work of the gold and silver smith. Those among us who desire to see this state of things re-established among the craftsmen of the present day cannot do better than study attentively the progressive development of German ironworking, from the close of the medieval period until the style known as baroque began to change the current of smithing.

"The new style came from across the French frontier and spread eventually over a large part, if not the whole, of Germany, changing the character of the design and modifying considerably all the traditions of the smith's craft. It was, however, but a mere wave of fashion compared to the overwhelming change wrought by the rococo, which followed and swept away every landmark of the smith. The lilies and passion-flowers, the tricky interlacings, threadles, and spirals which have been his peculiar pride, and the round bar itself disappeared at once, only to reappear in our own times. Highly-trained professional designers became indispensable, numbers of pattern books were published in imitation of the French, and the smith as creator and designer became extinct. The individual fancy of the workman in Germany could in future only be indulged, if at all, to the most limited extent. The designs were essentially French, but modified in the directions both of extra richness and less restraint. Though the skill and smithcraft in the finer examples is simply superb, the names of the smiths who produced them are never, unless accidentally, recorded. Whether this complete revolution was for good or ill is a debatable question."

Harmonizing Painted Glass with Other Details of Buildings.

THE fault of using painted glass in violation of good taste is more conspicuous in private than in public buildings, though in the latter may be found here and there egregious instances wherein incongruity is the most pronounced effect of an attempt to beautify by this,—when ably treated,—one of the most effective means of decoration. Doubtless the use of stained and painted glass should always be under the direction of cultivated taste. The fact is that it too frequently is the subject of the caprice of inartistic people,—building committees, etc.,—who are in no sense competent to decide where its employment would be sanctioned by the rules of art, but who must have it because it is the fashion; and who must have the same colors and patterns they have seen elsewhere, whether adapted to the proposed environment or not.

Architecture and Building quotes with approval (from a writer in *London Architect*) some sensible remarks upon the harmonization of glass paintings with associated architecture and sculpture. Without dwelling upon what is said of the subjects and treatment of glass paintings in their adaptation to different buildings, such as churches, libraries, etc., we pass to remarks comprehensible, not merely to professionals, but to all intelligent people.

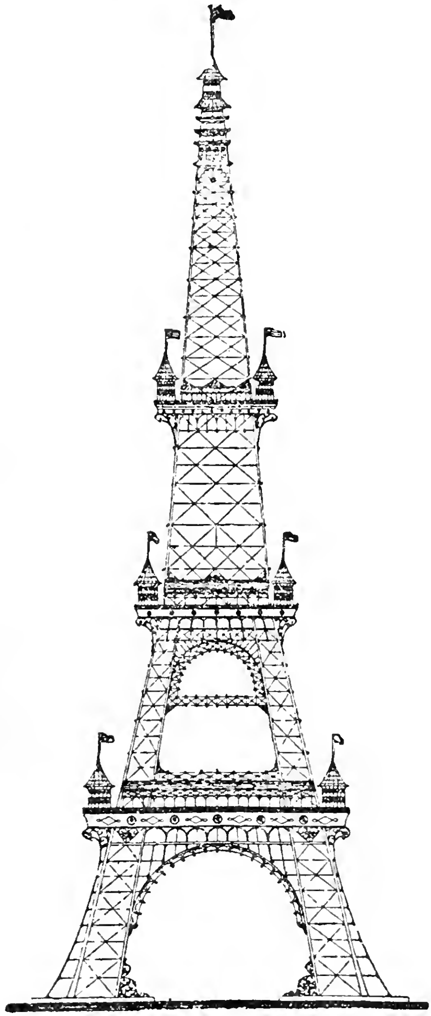
"If the interior of the building, or even the particular situation of the window, is dark and obscure, the glass painting ought to exhibit a predominance of deep hues; if the church or situation of the window is light in effect, a lighter cast of color would be preferable in the painted glass. If the character of the architecture is cheerful, the tone of the glass painting should be warm; if sombre and melancholy, the tone of the glass painting should be cold. Thus, buildings having dark interiors, by reason of their architectural construction (for additional gloom produced by the presence of painted glass is a circumstance quite beside the question), such as Westminster Abbey or St. Paul's Cathedral, would require more powerfully colored glass paintings than the Temple Church, or St. Clement Danes in the Strand: but, inasmuch as the character of Gothic architecture is somber and melancholy compared with that of the Italian, glass paintings designed for Westminster Abbey, or the Temple Church, should be colder in tone than those designed for St. Paul's or St. Clement Danes respectively. In like manner, painted windows situated in the dome of St. Paul's, or in the round part of the Temple Church, might require to be more deeply colored than painted windows in the choir of St. Paul's or in the choir of the Temple Church; yet the tone of coloring that would harmonize with any part of the Temple Church would be colder and more grave than that which would suit any part of St. Paul's Cathedral.

"It need scarcely be added that the details of a glass painting designed for St. Paul's Cathedral, or any other Italian church, should be of Italian character; or that the details of a glass painting designed for Westminster Abbey, or the Temple Church, should be in conformity with the details of those buildings respectively, and should in all other points be as advanced in point of art and general excellence as the architecture and sculpture are."

The author thinks that the harmony between Gothic architecture and coeval Gothic picture glass painting is not as complete as is generally supposed, although Gothic pattern glass painting harmonizes completely in the majority of cases.

The Chicago Tower.

NOT content with being the homestead of tall building, Chicago, like ancient Babel, wishes to have the highest artificial structure on the face of the earth. Nothing less than 1,115 feet in height will satisfy the passion of the Chicago people for looking down upon the inhabitants of



other cities. A tower of the height named is not only projected, but, *The Electrical Engineer* says, is in actual course of exploitation. Its cost is to be $800,000, and in external appearance it will be as shown in the engraving, reproduced from the journal named. If carried out as planned, this tower will be a great monument of architectural and engineering construction

The base will occupy a plot 326 feet square. " From the four corner supports, each of which is 50 feet square, will rise arches 200 feet across, and the same in height. These arches will support the first landing, which will have 90,000 square feet of flooring, where 22,000 persons can be accommodated at one time. There is a distance of 225 feet from the ground to this first landing.

" At a height of 450 feet there is to be a platform 150 feet square. Six hundred and seventy-five feet above the ground is the third landing, far higher than any building in Chicago. At an elevation of 1,000 feet above the earth is the fourth landing, and from there stairs lead up to the very top of the tower.

" Thirty-four elevators are to be used in this tower. They will be operated by electricity, the power being derived from the plant used in lighting the structure.

" The plan of having a United States meteorological bureau has been discussed at Washington and favorably considered by the officials of that department. The most important observations of all on such a tower would be those relating to atmospheric electricity. A few observations at the Washington monument have already shown some remarkable comparisons between the changes at that height and at the earth's surface. There is hardly a point regarding diurnal change, abnormal change, or seasonable change of meteorological element that would not be successfully aided by records from such a tower."

It appears to be supposed that people in and about Chicago (not having natural elevations of land from which to gaze afar, and satisfactory extension of view not being had from the roofs of the tall buildings hitherto available) will gladly part with their shekels for the privilege of being periodically lifted to the top of this structure, and that thus an income which will pay a fair profit on the proposed investment will be derived.

A revenue of considerable importance will also be derived from visitors to the city from various parts of the country, and from foreign travellers.

Corrosion of Lead Pipes.

THE corrosion of lead pipes may result from both internal and external causes. Speaking of the latter category, Mr. Oscar Kirby, in *Machinery* (London, Aug. 15), points out that lead pipes laid in trenches containing sulphate of lime in the material with which the trenches are filled (as from sweepings of floors in buildings where plaster of paris has been used in finishing walls) are liable to corrosion of an extent that may, and does, create leaks. If any of the fragments of the sulphate of lime come in contact with the pipe, the moisture in the filling condensing upon the outside of the pipe acts together with the sulphate to corrode the pipe. Also, atmospheric changes produce moisture upon the outside of a pipe, when built into walls, and this moisture combined with the lime will corrode the pipe and cause it to leak. The corroded parts of the pipe are generally covered with a red incrustation where honeycombed or eaten through. Yellow and red clay and peaty soil corrode lead pipes slowly, but blue clay and many kinds of sand will do so very quickly, and are the cause of much waste of water. The corrosion is different from that caused by lime, inasmuch as the surface of the pipe is eaten away without the formation of any incrustation. It is obvious that the corrosion of lead pipes from the outside, and the waste of water in consequence, can be guarded against.

So much for external corrosion. The lesson is plain; lead pipes should be isolated from sulphate of lime and other corrosive materials.

Internal corrosion is the result of acids, of which some water has present a notable quantity. In a paper read before the British Association, at its July meeting, the author exhibited samples of lead pipe very much corroded from this cause.

The samples attacked in this way were corroded all through the length. In pipes so injured fracture may occur at any point or at many points. Soft moor-land waters, which contain acid produced by decaying peat, act upon lead in this manner; but, if peat and other decaying vegetable matter are kept out of the impounding reservoirs, the acid is not produced, and, as a consequence, lead pipes are not acted upon.

Mr. Kirby says that, when service pipes are composed of English lead from which silver has not been separated, they resist the action of peat acid. He asserts that he has examined lead pipes which have been in constant use for thirty years, whose calibre and weight have been precisely the same when taken out as when they were put in, thus proving that no portion of the pipes had been washed away by acidulated moor-land water,—or, in other words, the water had no action upon them. As a substitute for good argentiferous lead, the pipes are frequently lined with tin about a millimeter in thickness; but in the production of tin-lined lead pipe the tin dissolves a considerable quantity of lead; consequently the lining is not pure tin, but a mixture of tin and lead; hence acidulated water drawn through these pipes and subjected to the sulphuretted hydrogen test distinctly indicates the presence of lead. As tin melts at a much lower temperature than that required in the solder by plumbers to make the joints in the pipes, it runs and fills the invert of the pipes, leaving them weak at the joints and partially filled up with tin. This accounts for the fact that these pipes so frequently burst near the joints. Of course they can be joined together with gun-metal cone connections without the aid of solder, but, inasmuch as the lining is an alloy of tin and lead, it does not effect the purpose intended. Tin-washed lead pipe has proved itself superior to the tin-lined lead pipe, the process of washing being done so quickly that there is not time for the tin to dissolve the lead. The washing is done by pouring molten tin into the pipe as it is forced through the die; the tin then washes against the inside of the pipe, and leaves a thin coat on the inner surface, and, if desired, the outer surface can be washed also. In joining these pipes the ends to be jointed should be filled for a few inches with table salt to prevent the tin-wash running when heated by the plumber's solder. The salt can easily be washed out of the pipes after the joints are made. Acidulated water drawn through these pipes does not yield the slightest trace of lead contamination.

The tin-washed pipes are, therefore, considered as decidedly preferable to the tin-lined pipes. The author states that expert investigation of cases of lead-poisoning attributed to contamination of water flowing through lead pipes has very rarely failed to show that the poisoning was due to lead absorbed into the system from other sources, and that the pipes were innocent.

Walls and Ceilings as Related to Sanitation.

THIS topic was brought before the congress of sanitary inspectors at Oban last June, and the pernicious practice of papering walls layer upon layer, as is frequently done, was strongly condemned. Cases were cited where no less than fifteen layers of wall paper had been super-imposed. It was clearly shown that paper used in this way becomes a *nidus* for infectious matter, to say nothing of its being a harbor for a class of insects which do most of their travelling and exploration by night. Size-coloring, commonly called kalsomine, while not harboring insects, is also condemned as unsanitary. The most sanitary finish that can be applied to plastered walls is oil-paint, which admits of thorough cleansing with water without disfigurement. Some might object that this reduces the permeability of the walls to air, but in an otherwise well-ventilated house this is unimportant.

Guarantees for Heating Contracts.

THE State inspectors of Massachusetts have issued a circular to school committees which will doubtless influence the framing of guarantees for heating and ventilating school buildings in other States. In this circular the inspectors say: "In the ventilation of school buildings the many hundred examinations made by the inspectors of this department have shown that the following requirements can be easily complied with: 1. That the apparatus will, with proper management, heat all the rooms, including the corridors, to 70 degrees F. in any weather. 2. That, with the rooms at 70 degrees and a difference of not less than 40 degrees between the temperature of the outside air and that of the air entering the room at the warm-air inlet, the apparatus will supply at least thirty cubic feet of air per minute for each scholar accommodated in the rooms. 3. That such supply of air will so circulate in the rooms that no uncomfortable draft will be felt, and that the difference in temperature between any two points on the breathing plane in the occupied portion of a room will not exceed three degrees. 4. That vitiated air in amount equal to the supply from the inlets will be removed through the ventiducts. 5. That the sanitary appliances will be so ventilated that no odors therefrom will be perceived in any portion of the building. To secure the approval of this department of plans showing methods or systems of heating and ventilation, the above requirements must be guaranteed in the specifications accompanying the plans."

A Correction.

IN our last number in the article on "Pipe Chases," our able and much esteemed contemporary, *The Engineering Record*, should have received the credit which was erroneously given to *Engineering News*. The names of these two excellent papers are so nearly alike that a mistake of this kind, though regrettable, is natural, and we are sure *The Engineering Record* will acquit us of any intent to give credit to the wrong source.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

Construction and Design.

*7603. The American Surety Building. Barr Ferree (An illustrated description giving much interesting information. The highest praise is given the architect for the beauty of the design, and the building is counted among the chief ornaments of Broadway, and among the most notable commercial buildings of the day. A beautiful type of stone construction). Stone—Aug. 2500 w.

*7609. A Short Description of the Rise and Decay of Gothic Architecture in England. F. J. Webber (Illustrated by cuts showing the evolution and decline described). Ill Car & Build–August 7. 2200 w.

*7612. Liverpool Museum Extension and Technical Schools (Perspective view, plans, and descriptive text of the selected design). Builder–Aug. 8. 1000 w.

*7613. Proposed Extension of the Edinburgh Municipal Buildings. R. Morham (Illustrated description and general remarks). Brit Arch–Aug 7. 1000 w.

*7616. The Brook Hospital, Shooter's Hill (Interesting illustrated general description). Arch, Lond–Aug. 7. 4500 w.

*7618. Church of Montivilliers (Interesting description, with inset, two-page line engraving). Arch, Lond–Aug. 7. 1500 w.

7629. A New Method of Fireproofing (Illustrated description of a new departure in fireproof construction used in the Barclay St. ferry house). Eng News–Aug. 13. 600 w.

7634. Recent Changes in Formulæ and Data Used in Determining the Strength of Materials. F. E. Kidder (The more recent formulæ and unit loads and strains at present most commonly used by structural engineers and architects). Arch & Build–Aug. 15. 1800 w.

7635. L'Enfant and the Planning of Washington. Charles Burr Todd (Historical note). Am Arch–Aug. 15. 800 w.

7781. The Harrison Building, Philadelphia (Illustrated description of constructive details. Part first contains general description, foundations, roof and beam plans, general sections and elevations). Eng Rec–Aug. 22. Serial. 1st part. 1700 w.

†7815. Style in Residential Architecture. C. E. Jenkins (The subject is discussed principally from the Chicago standpoint, the styles exemplified in that city being chiefly referred to). In Arch–Aug. 2000 w.

†7816. Chicago's Latest Steel Frame Building (Illustrated Description of the Trude Commercial Building). In Arch–Aug. 1500 w.

7830. A German System of Metal Stair Construction (The system illustrated and described is a Prussian invention). Eng News–Aug. 27. 400 w

7845. Church Architecture in America (Editorial review of a letter of Prof. Hamlin to the *Century*. Agrees with Prof. Hamlin that the majority of the modern churches of the United States lack dignity, repose, and ecclesiastic character). Arch & Build–Aug. 29. 800 w.

7847. Ancient Mural Decorative Art in Scotland. Thomas Bonnar (Read before the Edinburgh Archæological Association. The general character and the special characteristics of the art as exemplified in existing examples in Scotland). Arch & Build–Aug. 29. 4000 w.

*7855. Bonding of Brickwork (Illustrated description of a method of bonding with steel ties). Br Build–Aug. 600 w.

*7946. Principles Governing the Design of Foundations for Tall Buildings. Randell Hunt (The origin of these buildings, necessity of providing for settlement, the importance of knowing the exact character of the soil upon which the structure is to be built, comments on principles and discussions of different constructions). Jour Assn of Eng Soc–July. 9800 w.

8030. Specifications for Structural Iron and Steel. B. L. Worden, in the *Wisconsin Engineer* (A paper intended more especially for those whose experience is yet to be acquired, hoping it may lead to more complete study and better understanding of the subject). Arch & Build–Sept. 5. 1400 w.

8064. City Tower of Chicago (Brief illustrated description of a proposed structure). W Elec–Sept. 5. 600 w.

†8089. The New Cathedral of St. Thome, Mylapore, Madras (Interesting description). Ind Engng–Aug. 1. 2000 w.

Heating and Ventilation.

7668. An Extensive Single circuit Hot-Water System (Illustrated detailed description of plant for heating five buildings belonging to the Craig Colony for Epileptics at Sonyea, N. Y). Eng Rec–Aug. 15. 900 w.

*7677. The Principles of Gas Heating with an Example (Illustrated description of a new gas heater for apartments in buildings). Jour of Gas Lgt–Aug. 11. 2000 w.

7747 Steam Heating System in the United States Hotel, Paterson, N. J. (Illustrated description). Heat & Ven–Aug. 15. 400 w.

7898. Size of Registers and Flues for Indirect Heating. J. S. Bixby, Jr. (Chart from which the size of flues for indirect heating may be taken off without any computation, and description of method for using the chart). Met Work–Aug. 29. 350 w.

7918. Heating and Ventilating the First Baptist Temple, Brooklyn, N. Y. (Illustrated detailed description). Eng Rec–Aug. 29. 1800 w.

8017. Heating and Ventilation Apparatus of the Corcoran Gallery of Art, Washington, D. C. (Illustrated detailed description). Eng Rec–Sept. 5. 1600 w.

Plumbing and Gas Fitting.

7975. Return Circulation in Ordinary Plumbing Work. Charles Loraine (How to obtain a supply of hot water almost instantly when faucets are opened, whether they are or are not isolated from the reservoir. Illustrated by numerous diagrams). San Plumb–Sept. 1. 2000 w.

Landscape Gardening.

*7570. The Harmony of Architecture and Landscape Work. Ill. Downing Vaux (Stating the characteristics of landscape architecture in different nations, and the principles that guide the landscape architect in his work). Eng Mag–Sept. 2900 w.

7823 The Necessity of Planning. Charles Eliot (Utility and fitness must first be considered to most surely win expression, character and beauty). Gar & For–Aug. 26. 1200 w.

Miscellany.

*7577. The Ethics of the Sketch-Book. Paul Waterhouse (A word to students on the changed conditions which changes the purpose of the sketch-book, but does not destroy its usefulness). Jour of Roy Inst of Brit Archs–July 23. 2000 w.

*7578. The Training of Workers in the Applied Arts. Robert Anning Bell (Read before the Liverpool Soc. Causes that have retarded progress in architecture, sculpture and painting, and conditions to be desired in the relation of these arts). Jour Roy Inst of Brit Archs–July 23. 3000 w.

7592. The Nivet Apparatus for Testing Building Materials. From *La Nature* (Illustrated description of an apparatus for testing building materials (other than metals) that seems to be destined to render valuable services). Sci Am–Aug. 15. 2000 w.

*7602. The Mansfield, Indiana. Sandstone. T. C. Hopkins (Illustrated description of this building stone, the location, varieties, colors, etc). Stone–Aug. Serial. 1st part. 2800 w.

*7610. Architecture in the Capital of Tasmania (A general and entertaining description of the principal architectural features of Hobart, said to be the most English-looking city in Australia). Builder–Aug. 8. 3000 w.

*7611. New Infirmary, Halifax (A general description). Builder–Aug. 8. 1200 w.

7633. More Facts for Consideration (Editorial. Effect upon general trade, and particularly upon building enterprises, of the present agitation of the silver question). Arch & Build–Aug. 15. 1300 w.

*7679. Some Worcestershire Churches (Descriptions of special features, antiquities, etc., in the churches of Wyre, Throckmorton, Fladbury, Cropthorne and Wick in the diocese of Worcester, Eng). Arch, Lond–Aug. 14. 3000 w.

7720. Report of the Committee on Fireproofing Tests (This report was prepared by a committee of four gentlemen ; one appointed by the Tariff Assn. of New York, one by the Architectural League of New York, and two by the Am. Soc. of Mech. Engs. An account of the tests and the results is given, with diagrams and engravings). Arch & Build–Aug. 22. 1500 w.

7748. Some Points About Chimneys. Charles Desmond (Construction of chimneys for securing maximum efficiency). Heat & Ven–Aug. 15. 2000 w.

†7813. The Proper Unit Stresses for Timber. F. E. Kidder (A plea for uniformity in a standard of unit stresses, comprising a review of building laws in various cities as related to strength of materials). In Arch–Aug. 1600 w.

†7814. Plastering Methods and Materials. Thomas Jones (Substance of a paper read before the Illinois Chapter of the American Inst. of Architects, at Chicago. A scientific dissertation on the ingredients of mortar for plastering, their mixture, tempering, application, etc). In Arch–Aug. 4200 w.

7846. The Legal Duties of Engineers and Architects (Address of Pres. Jas. C. Bradford before the Engng. Assn. of the South. The relation of the architect and his employer is similar to that between lawyer and client, or of physician and patient. The moral and legal responsibilities involved in the relation are the theme of the address). Arch & Build–Aug. 29. 2200 w.

7852. Characteristics and Properties of Wood (Valuable information for architects and engineers, prepared by B. E. Fernow, of the Div. of Forestry Dept. of the United States). Can Arch–Aug. 3500 w.

*7853. Andrea Della Robbia and His Altarpieces. Allan Marquand (General characteristics which distinguish the work of the later Robbia school. the most striking of which is the production of terra cotta altar pieces. Specimen of this work illustrated in half-tone). Br Build-Aug. 1500 w.

*7854. A New Fire-Proofing System (System devised by Mr. George Rushforth, architect, of Stockton, Cal. Illustrated). Br Build–Aug. 250 w.

*7856. Colors for Country Buildings. A. Ashmun Kelly (Considers the relation of the color of buildings to the environment, and also to the character of the architecture). Pl & Dec–Aug. 1. 1000 w.

*7994. The Lithology of Building Stones. T. C. Hopkins (Thirty-eight varieties of stone are examined and the writer aims to give the best intepretation of the terms as an aid to those who have not made a special study of the subject). Arch, Lond–Aug. 21. 4800 w.

*7995. Industrial Design in Art Schools. Lewis F. Day (The author's impression on the teaching as he saw it, saying where it seems to fail, and how he thinks it might be bettered). Arch, Lond–Aug. 21. 4000 w.

8004. A Modern Office Building (Illustrated description of the roofing and cornice, plumbing and gas fitting, steam and hot water fitting, kitchen equipment, etc., of the Gerken Building, New York). Met Work–Sept. 5. 7800 w.

*8005. The New Congressional Library. E. A. Hempstead (Historical and descriptive, with plan and illustrations). Chau–Sept. 4800 w.

*8007. Quaint Houses in the Bermudas. Mary F. Honeyman (Interesting description of the architecture of these islands, with general remarks). Chau–Sept. 2500 w.

*8060. Model "Model Tenements." William Howe Tolman (Presents some of the results attained by English and Scotch cities). Arena–Sept. 3000 w.

*8085. A Restoration of the Mausoleum at Halicarnassus. J. J. Stevenson (A study of this mausoleum, which was one of the most noted structures in the ancient world, and the remains of which are now in the British National Museum). Builder–Aug. 29. Serial. 1st part. 3800 w.

*8086. The Most Remarkable Sight in Paris (Refers merely to the outward aspect of buildings and their surroundings. The writer thinks it the great modern church of the Sacré Cœur Montmartre). Builder–Aug. 29. 1300 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Calculation of Flood Waves.

THE Gohna landslip and flood, which will be generally remembered as having afforded one of the most remarkable instances extant of engineering calculation successfully applied to an extraordinary phenomenon, is recalled by *Indian Engineering* with apparently hypercritical comment.

The circumstances are well known: in September, 1893, an enormous landslip from the mountain of Maithana, on the right bank of the Birahi Gunga, swept across the river, damming it up completely; in October another great fall came down upon the first, making a barrier 900 feet high, 3,000 feet long on the top, and 600 feet long at the bottom of the gorge, with a cross section measuring 2,000 feet through at the top and 11,000 feet through at the base.

Behind this great dam were the rising waters of the river, soon to be augmented by melting snows and periodical rains; below, the narrow valley falling 250 feet to the mile at Gohna) stretched away 150 miles to Hardwar before debouching on the plains of northern India, and its course was dotted with shrines and traversed by streams of pilgrim devotees.

Protective measures against the inevitable flood were at once instituted by the government. Contoured maps of the valley were made, the area and volume of the lake which would be formed were accurately determined, the height of the flood-wave which would follow the bursting of the dam was calculated, danger lines marked, signal stations established, and property within the menaced area as far as possible removed or dismantled.

Most remarkable of all, the date when the rising waters would overtop the dam was fixed within ten days, the error being on the safe side: the flood actually occurred on August 25 (instead of August 15 as precalculated), and, thanks to the precautions taken, not a single life was lost.

The *Indian Engineer* thinks that a different management of affairs at the crest might have brought the final breach during the daytime, instead of at night; but a careful perusal of the authoritative account makes it apparent that every effort was made to this end, and the failure was due to causes beyond the engineer's control; but, further than this, the *Engineer* is distressed because the motion of a flood-wave of the character has not been reduced to rule, and the credit for the remarkable accuracy of the predictions in this case is to be ascribed wholly to the engineers in charge. "The highest level touched by the flood at every point along the line was guessed by Colonel Pulford in advance, with an approximate correctness most surprising, but all of us can scarcely always hope to have such happy intuition or such luck. Given the details of a channel, and varying volume of some short-time discharge entering into it, we ought to have some sound, if approximate, theory to show the maximum flood-level at each point down stream."

"The details of a channel and varying volume of a short-time discharge" involve such an infinity of variations and permutations that the "sound, but approximate, theory" could be nothing but a compilation of manifold independent solutions of as many different problems. It is, to say the least, extremely doubtful if any general formula (which seems to be the point *Indian Engineering* is striving for) can possibly be deduced or applied at all.

The form, contour, and configuration of the main valley and its tributaries, the material composing the banks, the volume and condition of the main stream before the flood wave is super-imposed, the state of all tributary channels, and the rate of liberation of the flood are all factors which may vary the calculation between limits so wide that any suggestion of a "general theory" seems idle. The solution must be found in intelligent study of each case, such as that which made the Gohna flood a memorable exemplar of the exactness of engineering science.

It is of interest to note that our own weather bureau has recently undertaken a similar, if somewhat less brilliant, service with relation to the winter floods on western rivers. Their predictions as to expected stages are still of too recent inauguration to win absolute confidence, but may be made a feature of incalculable value. The experienced river-man who hangs about the bulletin boards in our western river cities and confidently predicts " how many more feet she's a-comin " is picturesque, but very unreliable.

His basis of calculation is usually wholly empirical, having for its foundation usually some particularly remembered difference between up and down river points observed during a former flood, and confidently expecting a repetition of the same difference at every succeeding one, with calm indifference to widely varying conditions in the intervening tributaries or the local rainfall. The ancient prophet is always absolutely confident that a freeze " checks the flood," never having discovered that the flood-making waters are in the rapidly-flowing stream a few hours after the rain falls on the water-shed, and are thenceforth unaffected by even severe cold.

The fact that the first days of a thaw do not affect the river, if observed, remains an unexplained mystery, when a tramp across any snow-field would serve to show that the snow acts as a sponge, holding back, in its lower layers, the water first melted, and suddenly liberating all, when the last few inches are thawed.

Such extraordinary disasters as the Gohna flood are rare, but the western flood we have always with us, and exact and reliable precalculations would be of inestimable advantage to the business enterprises necessarily located with the flood limits; even if a " sound, but approximate, theory " is hardly to be expected, the engineer can find here a field for useful and profitable calculation.

The Age of Projected Ship Canals.

THIS appears to be the age of the discussion of ship-canals, if the term " discussion " be properly applied to the advancement of more or less practicable schemes by some enthusiastic advocate, and their prompt retirement into oblivion, for a period at least.

The remarkable feature of the movement is the slender basis of practical, successful enterprise by which so much projected construction is suggested. The Suez canal, of course, remains as the shining example of a substantial revolution in commercial routes effected by canal construction, although it has by no means caused an entire abandonment of the route to the east around the Cape of Good Hope; but this particular enterprise was favored at once by the possibility of securing an enormous saving in distance, and the absence of serious engineering difficulties in its construction.

If the conditions had been equally favorable as to the second point on the Isthmus of Panama, no doubt one, and possibiy two, artificial waterways would have long since intersected it, furnishing new stimulus to commerce and incidentally to the ship-canal idea; but here the engineering difficulties have so far prevented an economical solution, and it is still incumbent upon the projectors to show cause why nature's temporary injunction should not be made permanent.

In the cases of other recently-completed undertakings, the saving of time, distance, or cargo-handling does not seem to have proved as tempting to navigators as precalculated, and new waterways, from which much was expected, languish in comparative idleness.

Such is the Baltic and North Sea canal, to which the officials, according to recent report, are hoping to attract a much needed increase of tonnage by readjustment of the tolls; and from all accounts the Manchester ship canal has proved somewhat similarly disappointing.

But the schemer is still undaunted. The project of a canal from the Bay of Biscay to the Mediterranean has recently come up again for its periodical killing.

In fact, ship canals are "in the air"; an excited astronomer sees them on the planet Mars, and, possibly because the Martian "canals" are seen double, one engineer is exploiting a scheme for paralleling the Suez canal by a new route, starting from the Bay of Aboukir, cutting into the Nile, following the stream for some distance, and thence striking eastward into the gulf.

In our own country there is urged the importance of an outlet from the great lakes to the Mississippi, at the western end, and one to the Hudson, at the eastern; more recently still, we have had the clamor of the competing advocates of two, or maybe three, routes from Lake Erie to the Ohio, although, as one unkind critic says, it seems of doubtful expediency to carry a sixteen-foot canal into a five-foot river.

As a matter of fact, marine commerce, as conducted at present, is not eager to secure a small net saving at any great risk or difficulty of navigation. The successful ship canal must either offer a material reduction of time in transit, or, if this saving be small, it must give easy navigation and very moderate tolls, which means that it can be successfully constructed only in situations where the conditions permit of good engineering work at reasonable cost.

No doubt the canal system of this country can be largely developed to most excellent advantage. The possible political benefits of an independent outlet for our lake commerce through our own territory to the sea are plainly manifest.

Many of the other projects may ultimately be carried to a successful and profitable conclusion; but the conditions at Suez are not often repeated, and the economic conditions of the times are hardly suited to any brilliant, but possibly uncertain, effort to eclipse it.

The Health of Caisson Workers.

A NOTABLE development in recent engineering construction is the larger application found for compressed air. The sudden and rapid growth of the tall building especially—by many persons regarded as the most striking departure in modern engineering—has made almost an every-day application of a method once held in awe by the laity, and regarded, even by the profession, as an unusual incident of underground work, appropriate chiefly to bridge and tunnel construction.

With so extended use and increase in the number of men employed, there has naturally arisen a heightened interest in the hygienic relations of the system, and a concentration of study upon the elimination, or at least the reduction, of the risk which attended the early undertakings of this character.

Improvement in mechanical appliances happily has lessened the number and seriousness of sudden disasters; the study of able and painstaking investigators, in both the engineering and the medical profession, seems likely to result in an equal betterment of sanitary conditions. In the August number of THE ENGINEERING MAGAZINE we reviewed the very practical success of Mr. E. W. Moir, one of the most successful submarine-tunnel engineers, and especially his device of the "air-lock" for treating, by a gradual reduction of pressure, workmen who had been overcome by the effects of a compressed atmosphere. A recent number of the *Sanitarian* gives an abstract of a consular report embodying the conclusions which an Austrian authority, Dr. Neudorfer, derives from an independent study of the same subject.

Dr. Neudorfer's conclusions, confirmatory of the opinions of Rameaux and Paul Bert, are thus summed up.

"There are two things that the workers in caissons have to guard against:

"(1) The concentrated oxygen, which, at a pressure of five atmospheres, affects the nervous system injuriously, causing cramps, tetanus, diminishing oxidation, and the formation of carbonic acid gas. It has been proven by experiments on men and animals that, when there is an increase of twenty per cent. in the amount of oxygen, the process of oxidation in the body is less rapid, less carbonic acid gas is formed, and the heat of the body is diminished. This first danger is the least serious, as the pneumatic pump causes a gradual compression of oxygen, to which the system generally adapts itself; and in any case there are premonitory symptoms which make it possible to remove the workmen before the case becomes dangerous. Little inconvenience is caused, until the pressure exceeds four atmospheres.

"(2) The concentration of nitrogen, which affects the blood instead of the nervous system. With the increase of pressure, the nitrogen becomes more and more concentrated, and the absorption of this gas by the blood increases proportionately; when a decrease in the atmospheric pressure causes the absorption of a smaller quantity of nitrogen, the gas escapes in fine bubbles, which circulate through the veins and prevent the blood, by their expansion, from circulating in the capillary veins. This checks the flow of arterial blood, and affects the spinal column and the brain. In experimenting with animals, death is caused instantaneously when a high pressure is suddenly reduced. The best method for obviating this danger is to reduce the pressure slowly, so that the blood can get rid of the free nitrogen gradually. At the entrance to the caisson there should be a separate compartment filled with compressed air. When the workman desires to leave his work, he should shut himself in this compartment, and gradually reduce the pressure by letting the compressed air escape.

"According to the opinion of Dr. Neudorfer, of Vienna, an hour and a quarter should be spent in reducing the pressure of 3½ atmospheres, in order that the risk may be as small as possible. The decrease of pressure is regulated according to the regulator of Denayrouze.

"In cases where, in spite of all precautions, a workman is affected, inhalations of pure oxygen are found to be the most simple and effective remedy."

The similarity of Dr. Neudorfer's remedial treatment to that proposed by Mr. Moir is striking. There is a partial accord between the opinions of the two authorities as to the causes which produce the disordered circulation; but, while Mr. Moir was inclined to consider carbonic acid the chief disturbing agent, Dr. Neudorfer evidently finds it unnecessary to look beyond the ordinary constituents of a normal atmosphere,—oxygen and nitrogen.

Engineering as a Closed Profession.

"HER Majesty, by and with the advice and consent of the legislative assembly of the province of Manitoba," has enacted a bill "which may be cited as the Manitoba Civil Engineers' Act," by which the profession is closed in the province of Manitoba.

This is in line with the tendencies which have recently been so strongly marked, both in public and private expression, throughout the dominion, and the passage of the act seems to have been directly secured by the influence of the Canadian Society of Civil Engineers, working through their committee. It will be generally regarded, in the country, as a step backward; but an examination of the text of the bill shows the step to be almost amazingly short and hesitating. Sixteen of the eighteen sections are devoted entirely to the organization, constitution, and administration of The Canadian Society of Civil Engineers; the remaining two sections are as follows:

17. On and after the 1st day of July, 1896, no person shall be entitled within this province to take or use the name and title of "civil engineer" or any abbreviation thereof, either alone or in combination with any other word or words, or any name, title, or description implying that he is a member of the said Society of Civil Engineers, or act as engineer in laying out, advising on, constructing, or superintending the construction of any railway or public work, or any work upon which public money is expended, the cost of which shall exceed $500, unless such person is a member of the Society hereby incorporated and registered as such under the provisions of this act, or unless he is a duly qualified civil engineer, and entitled to use the title of civil engineer by virtue of some statute in force in this province, or by the authority of some institution of learning in this province having authority to confer degrees in civil engineering, or unless he has been practising as a civil engineer in this province at the time of the passing of this act, or unless he is a member in good standing of some institution of civil engineers in

Great Britain and Ireland, or of some national society of civil engineers of good standing in any foreign country.

18. This act shall be deemed a public act.

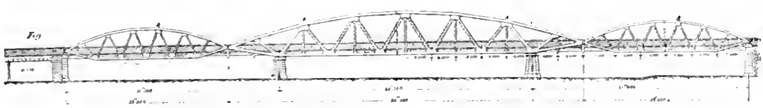
As remarked by the *Engineering News*, from whose columns we quote the reprint of the bill, "the breadth of the exceptions is praiseworthy; but it is also to be noted that the law provides no pains or penalties for those who disregard its provisions."

It is rather severe on the registrar of the society who shall "make or cause to be made any falsification in any matter relating to the register," but a violation of the act itself is not even declared to be a misdemeanor.

To commend an act for its omissions and exceptions is decidedly to damn it with faint praise, but it is the only ground upon which commendation could be extended to a measure which, in principle, has no justification in public policy, and can scarcely fail to result in formalism and stagnation within the profession.

An Interesting Bridge Design.

A BRIDGE recently completed in Paris, and designed to carry a new street—the Rue Tolbiac—across the station-yard of the Orleans railway, is briefly noted by *Engineering*, with the promise to return to the subject when further illustrations are published.



THE RUE TOLBIAC BRIDGE.

It is said to present "some interesting constructive features," one of which is the peculiar form of the central span, which extends over the piers, as shown by the accompanying illustration, carrying on its projecting ends the ends of the girders of the two outer spans.

The key to the unusual construction will, no doubt, be found in the peculiar conditions attending the erection of the bridge, which are described as "exceptionally difficult, not only on account of the binding gradients, but also because the bridge had to be erected without interfering with the constant and heavy traffic of the station yard." In all probability the conditions of this traffic and the unalterable location of track so predetermined the placing of piers as to render this somewhat novel solution of the problem most expedient and economical.

The total length of the bridge is 525 feet between abutments, and it is divided into three spans, the center one of which rests on two piers: the distance between the piers is 196 feet 10 inches, and the length of the central girder is 275 feet 7 inches; the width of the bridge is 55 feet 9 inches. The work is the design of M. Salles, Ingénieur des Ponts et Chaussées, and it was erected under the direction of MM. Huet and de Tavergnier.

European Inland Waterways.

IN connection with the discussion of canals, great and small, it is of considerable interest to observe the attitude of the English press and public toward their canal system, which, though apparently unsatisfactory to them, is certainly developed to a much higher extent than we have as yet contemplated in this country. A British contemporary says: "It does appear strange that so little attention is paid to our canals, not only by the Board of Trade but by the public generally. Possibly the supreme financial importance of the Manchester Ship Canal causes one to overlook the fact that there is still such a system in actual operation, and that it conveys annually a considerable quantity of merchandise, as our recent articles on English canals have shown. The official, *i. e.*, Government, returns of these waterways is of by no means recent date, nothing having been issued on the subject since 1890, and the Blue Book of that year dealt only with figures up to 1888. Private research, however, shows that railway competition has by no means exercised such disastrous effect upon traffic by canal as by stage coach and wagon. The following particulars dealing with the year 1893-4 may prove interesting:

	Miles.	Traffic. Tons.	Revenue. £
England and Wales	3050	34,325,179	1,876,423
Ireland	609	519,580	95,864
Scotland	154	1,456,361	69,189

Of these the canals owned and worked by railway companies were as follows:—

	Miles.	Traffic. Tons.	Revenue. £
England and Wales	1024	6,60?,304	437,080
Ireland	96	30.368	6,495
Scotland	84	1,386,617	57,178

The capital expenditure was estimated to amount to £32,749,793. Another interesting fact about our comparatively neglected and despised waterways is that they show to better advantage than do those of our continental neighbors. In 1895 a Foreign-office return was issued, which showed that Germany possessed only 1349 miles of canals and canalized rivers, which had cost for construction, maintenance, etc., between 1880 and 1893, £11,677,750, and France had 3003 miles of canals, on which had been expended by the government £20,638,861. But, however well we bear comparison with these two up-to-date continental neighbors, it appears a pity that more use cannot be made of our inland waterways. Sir John Brunner is of the opinion that they could be so improved as to be of more benefit to trade than the proposed light railways, and undoubtedly there is much in what he says.

There are miles upon miles of canals in the kingdom which are practically idle. Certainly in some cases an attempt is being made to improve matters. In connection with the Worcester Canal, for example, which may in time render it possible for small coasting steamers to reach Birmingham, and this is perhaps as large a class of steamers as it is desirable to cater for. However much a ship canal capable of accommodating larger vessels may gratify the vanity of our inland towns, there are few of them which could support such an enterprise. It would be enough for them to be able to accommodate steamers of up to 400 to 500 tons cargo, with goods to be transhipped to waiting liners at our great ports. In connection with the majority of our at present little used canals, even this would be unnecessary. A service of steam launches to tow canal barges would be quite enough, and were this applied to canals at present either not utilized at all, or used only to a small extent for traffic in connection with the transport of goods where time is of minor importance, a great benefit would be conferred upon community and canal owners."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

7632. The Design and Specifications for the Fairmount Park Bridge. John Sterling Deans (Letters setting forth the facts relating to this structure. A protest was presented to the commissioners of Fairmount Park against the award of the contract). Eng News–Aug. 13. 5200 w.

7662. Bridge Over Minnesota River—Minneapolis and St. Louis Railroad (General view and principal details of a three span Pratt combination bridge). Ry Rev–Aug. 15. 400 w.

7723. The New Albert Bridge, Near Brisbane, Australia (Descriptive account with illustrations). Ry Rev–Aug. 22. 1800 w.

*7741. Suspension Bridges (Comments on the probable revival of the suspension bridge with a stiffening truss, and discusses the bending moments in a two-hinged and three-hinged girder). Engng–Aug. 14. Serial. 1st part. 1600 w.

7824. The Cernavoda Bridge Over the Danube River (Illustrated description of cantilever bridge). Eng News–Aug. 27. 800 w.

7872.—$1. The Reconstruction of Grand River Bridge. W. A. Rogers (Illustrated description with statement of cost for the different kinds of work). Trans Am Soc of Civ Engs–Aug. 5500 w.

*7948. Riveted Joints. Joseph R. Worcester (The subject of increase of strength of riveted joints under ordinary working strains, due to the friction of the contact surfaces of the plates or shapes riveted together, and the question of how much of the strength of the joint is due to this friction. Data and conclusions, tests and experiments, with discussion). Jour of Assn of Engng Soc–July. 9500 w.

*8072. The Tolbiac Bridge in Paris (Illustrated description of a bridge which has recently been constructed under special conditions, and presents many novel and interesting features in its design). Engng–Aug. 28. 2700 w.

8109. The New East River Bridge (States the changed conditions which make a bridge connecting New York and Brooklyn farther north a necessity, its location and a brief illustrated description). Sci Am–Sept. 12. 1700 w.

Canals, Rivers and Harbors.

7631. A Proposed New Location for a Nicaragua Ship Canal. J. T. Ford (A skeleton sketch with a proposed survey which the writer thinks would economize). Eng News–Aug. 13. 1000 w.

7649. Caisson, North Pier Head, Madras Harbor. Robert W. Thompson (A paper read before the Inst. of Civ. Engs. Describes caisson building and sinking, and construction in the dry of monolithic pier heads of concrete). Ry Rev–Aug. 8. 2500 w.

7706. Effect of Engineering Works on Water Currents (Effect of combined wind and water action with maps of typical river outlets and an illustration of an unwise attempt at river regulation. Abstract of paper read by Mr. Cyrus Carroll, before the Canadian Society of Civil Engineers). Eng News–Aug. 20. 600 w.

7842. The Chicago Drainage Canal (Historical and descriptive account, with some figures). R R Gaz–Aug. 28. 2000 w.

*8006. Joining the Atlantic to the Pacific. George Ethelbert Walsh (A review of interesting facts connected with the three great canal routes whose construction has engaged the attention of the commercial world). Chau–Sept. 4500 w.

8016. Hydraulics of Rivers Having Alluvial Beds. Abstract of paper by George Y. Wisner (A study of the movement of water and sedimentary material in rivers). Eng Rec–Sept. 5. 2000 w.

*8100. Docking the River at Swansea (A scheme under consideration, with plan. The advantages and objections). Eng, Lond–Aug. 28. 1000 w.

Hydraulics.

7581. Hydraulic Apparatus. William Perry (Causes that enable the syphon to perform its work, and the origin of the name "ram" and why applied to the invention bearing its name). Can Eng–Aug. 1200 w.

7626. Locks and Dams on the Great Kanawha River, W. Va.) Information, with illustrations, of work done on this river, showing that the government money has been wisely expended in this case and the results satisfactory). Eng News–Aug. 13. 1800 w.

7705. The Foundations of the Herr Island Lock and Dam, near Pittsburg, Pa. (Illustrated description). Eng News–Aug. 20. 900 w.

*7949. A Low Crib Dam Across Rock River. J. W. Woermann (Illustrated description of one of the structures of the Illinois and Mississippi Canal, built for the purpose of furnishing slack water navigation in Rock River above the Lower Rapids. The crib-work, or dam proper, only are considered in this paper). Jour Assn of Engng Soc–July. 3800 w.

8034. Vertical Lift Lock for Dortmund and Ems Canal, Heinrichenburg, Germany (An illustrated description of a lock possessing several novel features in its construction. It corresponds in size to the proposed lift lock in the Erie Canal at Lockport, N. Y., and is interesting to study the ideas of foreigners in the solution of their similar problem). Eng News–Sept. 3. 1000 w.

8039. Water Development on the Mojave River, near Dagget, Cal. J. B. Lippincott (Illustrated description). Eng News–Sept. 3. 1800 w.

Miscellany.

†7573. Data Pertaining to Rainfall and Stream Flow. Thomas T. Johnston (An account of methods and a general discussion accompanies the extensive tables of results of systematic observations presented in this valuable contribution to engineering data (Jour of West Soc of Engs–June. 4800 w.

†7574. Notes about the Geology and Hydrology of the Great Lakes. P. Vedel (A summary of what is known of the nature and origin of the great American lakes, with geological and hydrographical maps and charts). Jour of West Soc Engs–June. 11000 w.

7699. The Richer Tachymeter. F. D. Lyphart (The history, description and theory of an important instrument). Eng News–Aug. 20. 900 w.

7701. Who Should Prepare Specifications? (An editorial upon the proper attitude of the profession toward this question). Eng News–Aug. 20. 1300 w.

7702. Fishway for Dam at Sterling, Ill. (Illustrated description). Eng News–Aug. 20. 100 w.

7703. Civil Engineering a Close Profession in Manitoba (Text, and general remarks, of an act regulating the professional practice of civil engineering in Manitoba, approved March 19, 1896). Eng. News–Aug. 20. 1800 w.

7803. The Road of the Future.—Solution of the Bad Thoroughfare Question (Advocacy of steel-rail roadways, by Gen. Stone of the Agricultural Dept). Clay Rec–Aug. 12. 1300 w.

7831. Impermeable Covering for Stone Arches (The covering herein described and discussed, with directions for preparation and application, is a mastic asphalt, used to prevent infiltration of rain water). Eng News–Aug. 27. 1000 w.

7870.—$1. The Suspension of Solids in Flowing Water. Elon Huntington Hooker (An important and laborious dissertation with formulæ and tabulated data). Trans Am Soc of Civ Engs–Aug. 30000 w.

*7940. Allowable Magnesia in Portland Cement. Irving A. Bachman (A review of investigations and discussions of the question of magnesia in Portland cement since 1891, looking to the maximum percentage permissible without endangering the quality of the cement). Munic Engng–Sept. 2000 w.

*8099. The Port Talbot Railway and Dock (Descriptive account of an extensive project for developing a Welsh coal district, and coal-shipping port). Eng, Lond–Aug. 28. 3300 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

The Latimer Clark Cell.

THIS standard cell, legalized by the British board of trade, is of such value and importance in electrical engineering that it has been made a part of the syllabus of a number of engineering schools. The legal E. M. F. of the cell at fifteen degrees C. is 1.434 volts. Mr. J. Warren, in *Electricity* gives elaborate instructions for the preparation of this standard cell, from which—passing over some general remarks—we condense what follows, which may be of use to any amateur who wishes to make up one of these standards. The materials are as follows:

Pure mercury; neutral solution of zinc sulphate; a rod of pure redistilled zinc; mercurous sulphate; zinc oxid; platinum wire of about No. 22 B. W. G.; a wide-mouthed test-tube; and a cork to fit the mouth of the test-tube.

The mercury must have been recently purified by washing with acids and redistillation in a vacuum. The mercurous sulphate, sold as pure, must be twice or thrice, successively, washed with pure cold distilled water, in a flask, and shaken thoroughly, and the water must be drained off as much as possible after the final washing.

The mercury forms the negative pole in the bottom of the cell, through and into which the platinum wire may be fused, leaving a free end on the inside coiled into a spiral for contact with the mercury, and a free end outside for a terminal connection.

Mr. Warren prefers to pass the platinum wire down into the mercury through a sealed glass tube inserted through the cork finally used to seal up the cell, and extend this tube down into the mercury below its upper surface; this will be found the most convenient way for amateurs in making up these cells. The wire should be passed through and sealed into the ends of this protecting tube by fusing the glass upon the wire with a blow-pipe.

The cell, when made up, consists of the mercury in the bottom of the tube with its platinum contact, a supervening electrolyte of a paste made by mixing mercurous sulphate with saturated solution of zinc sulphate, and the positive zinc rod, to the upper end of which a copper terminal is soldered. But, in making up this cell, as in many other things, the practical details are of great importance, and it is only by careful attention to these that the standard E. M. F., without which the cell is worthless, can be obtained.

Make a saturated solution of pure recrystallized sulphate of zinc, by mixing in a flask distilled water with nearly twice its weight of the crystals of pure zinc sulphate, adding oxid of zinc in the proportion of about two per cent. by weight of the zinc sulphate crystals, to neutralize any free acid. The crystals should be dissolved with the aid of gentle heat, but on no account should the temperature to which the solution is raised exceed 30° C.

Mercurous sulphate, treated as described hereafter, is then added in the proportion of about twelve per cent. by weight of the zinc sulphate crystals, and the solution filtered, while still warm, into a stock bottle. Crystals should form as the liquid cools.

At temperatures above 30° C. the zinc sulphate may crystallize out in another form; to avoid this, 30°C. should be the maximum temperature limit. At this temperature water will dissolve about 1.9 times its own weight of the crystals. If any of the latter remain undissolved, they will be removed by the filtration.

The amount of zinc oxid required depends on the acidity of the solution, but two per cent. will be ample in all cases which arise in practice, with reasonably good sulphate of zinc. Another rule for the addition of the oxid would be to add gradually until the solution becomes slightly milky.

The solution, when put into the cell, must not contain any free zinc oxid ; if it does, then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxid are formed, and the latter may be deposited on the zinc, thus affecting the electromotive force of the cell. This difficulty is avoided by adding, as above described, about twelve per cent. of mercurous sulphate before filtration. This is more than sufficient to combine with the whole of the zinc oxid originally added, if it all remains free ; the mercurous oxid formed, together with any undissolved mercurous sulphate, is removed by the filtration.

Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of sulphate of zinc from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well, together, to form a paste of the consistency of cream. Heat the paste, but not above a temperature of 30° C. Keep it for an hour at this temperature, agitating it from time to time, and then allow it to cool; continue to shake it occasionally while it is cooling. Crystals of sulphate of zinc should then be distinctly visible, and should be distributed throughout the mass. If this be not the case, add more crystals from the stock bottle, and repeat the whole process. This method ensures the formation of a saturated solution of zinc and mercury sulphates in water.

The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate, which is often present as an impurity. Mercuric sulphate decomposes in the presence of water into an acid or a basic sulphate. The latter is a yellow substance (turpeth mineral) practically insoluble in water ; its presence, at any rate in moderate quantities, has no effect on the cell. If, however, it be formed, the acid sulphate is formed also. This latter is soluble in water, and the acid produced affects the E. M. F. of the cell. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the washings previously described will, in nearly all cases, suffice. If, however, a great deal of the turpeth mineral is formed, it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than try by repeated washings to get rid of all the acid. The free mercury assists in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid, which is washed away.

Having thus prepared the various materials, the cell is made up as follows: At the bottom of a small test tube of about 2 c.m. diameter and 6 or 7 c.m. deep place the mercury, filling to a depth of about 1.5 c.m. Cut a cork about 5 c.m. thick to fit the mouth of the tube ; at one side of the cork bore a hole, through which the zinc rod can pass lightly, and at the other side bore another hole for the reception of the glass tube containing the platinum wire ; at the edge of the cork, cut a nick, through which the air can escape when the cork is pushed into the tube. Wash the cork thoroughly in warm water, and leave it to soak for some hours before use. Pass the zinc rod about 1 c.m. through the cork, clean the glass tube and platinum wire carefully, then heat the exposed end of the latter red-hot, and insert it in the mercury in the test-tube, taking care that the whole of the exposed platinum is covered.

Shake up the paste, and introduce it without contact with the upper part of the walls of the test-tube, filling the latter above the mercury to a depth of rather more than 2 c.m. Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least twenty-four hours before sealing,—an operation which should be performed as follows: Melt some marine glue until it is fluid enough to pour by its own weight, and pour it into the test-tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube, however, should project above the top of the marine glue.

The cell may be sealed in a more permanent manner by coating the marine glue, when set, with a solution of sodium silicate, and leaving it to harden.

The cell, thus completed, is standardized by comparison, and may then be mounted in any desirable manner. It will be found convenient to arrange the mounting so that the cell may be immersed in a water-bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than when the cell is in the air.

Electrical and Mechanical Engineering.

IN our "Review of the Industrial Press" we are often embarrassed to decide what department of the review would most appropriately receive the indexed title of some article. The boundaries — never sharply defined—between the specialities of engineering become more and more indistinct as time advances. It thus becomes difficult in many cases to decide whether a title should go under "Marine Engineering," or "Mechanical Engineering," or "Civil Engineering," or "Architecture," or "Electricity," etc. Of late, the puzzle with reference to electricity and other divisions of engineering has increased. Electricity is entering as a factor into every industrial activity, and a dissertation upon some one of its applications may seem to treat it more from the mechanical side than from the electrical side, and *vice versa*. Comparatively few articles relating more or less to both electrical principles and their industrial applications deal exclusively with either electrical or mechanical aspects.

The intimate connection between what can be considered unequivocally mechanical engineering, and what is purely electrical, in mechanical devices wherein electricity is applied, or in scientific electrical appliances which involve skilled mechanical construction, is creating a wide border-land which, by its very nature, must be held in common.

These remarks were suggested by an editorial in *Journal of Gas Lighting* (Aug. 1), in which the overlapping of electrical and mechanical engineering is traced from the early days of the telegraph down to the present date. When electric telegraphy had its beginnings, the "electrician" predominated, and "the title was recognized as representing a distinguished profession embracing the highest attainments in electrical practice and theory. An electrician in those days was looked up to with a feeling akin to awe and superstition by his contemporaries in other branches of mechanical work and by the general public. The marvels of the quadruplex and the ability to locate, by means of the Wheatstone bridge and the galvanometer, the exact position of a break or leak in a cable buried in mid-ocean seemed not the least of the astonishing features of the electrician's art, and very justly so."

Twenty years have brought about a marvellous change. In the field, the mine, the work-shop, the exchange, the mercantile establishment, the street, the ship that carries us across the sea, the vehicle that whirls about in towns and between towns and suburbs, the hospital, the hotel, the prison, and the domestic home, electricity is doing useful work, with mechanical design and construction of the highest order as its industrial handmaids. The mechanic of to-day frequently knows enough of electricity to have set up in trade an electrician of the forties. The electrician of to-day is often a better mechanical designer and constructor than could have been found without difficult search in the fifties. "The practical electrician of former times, who was fully qualified in the application of Ohm's law to the measurement of resistances and to the electrical testing of batteries and circuits, seemed to be, in the majority of cases, quite incapable of developing the mechanical constructive ability needed in the newer and heavier work which the generation and commercial application of these more powerful electric currents have called into existence." All this has changed. "There is, of course, and always will be, an enormously large field for the profitable exercise of a thorough mechanical training. But, in view of the growing use of the dynamo and electric motor in manufacturing establishments and in modern machine-shop practice, in which they are now either supplanting or supplementing the steam boiler and engine (to say nothing of the increasing use of electricity in other technical and industrial processes), the up-to-date mechanical engineer must familiarize himself, if not with the fundamental principles of electrical science and the elements of electrical and electro-magnetic calculations and measurements, at least with the mechanical design, construction, operation, and control of the dynamo and motor and its general applications, in so far as the same may be useful to him in determining to what extent and in what connection the employment of electrical energy as a motive or controlling force may best be used in his construction work and other problems arising in his daily practice. Electrical applications, in fact, are so rapidly assuming an important place in nearly every department of engineering that an elementary knowledge of the science and its various uses in connection with his special department is to-day an essential requirement of every engineer, and particularly of the mechanical engineer."

But there remains a field for the purely scientific electrician. No one will assert that we have more than just entered upon the wide field of investigation presented by electrical phenomena, and this field will, for a long time, attract into the ranks of its explorers the foremost minds of successive generations.

Electric Railway Connecting New York and Philadelphia.

THE extension of electric propulsion to railroad lines of considerable length is to have its commercial practicability tested. The announcement that a syndicate of New York and Philadelphia capitalists will undertake to construct and operate an electric railroad between the cities named, which are nearly one hundred miles apart, has been made, coupled with the statement that the work will soon be commenced.

From the engineering standpoint, there appears no reason why such a road could not be operated between New York and San Francisco. The success or failure of such an enterprise must always depend upon the receipts and expenditures. If these can be so related to each other over a distance of one hundred miles that a greater margin of profit can be retained for the investors than by other modes of propulsion, the question of electric motive power on trunk lines may be regarded as settled.

Of course, local conditions affect the question of feasibility; and through thickly-settled regions such conditions generally are favorable to electricity. Near New York and also near Philadelphia thickly-populated suburbs will contribute to the receipts of an electric road, without a proportionate increase of expenditures. The importance of this consideration as affecting the possibilities of the new road will appear from the following quotation (*The Electrical Engineer*, Aug. 19).

"The direct line of the main stem will begin at Paterson, where connection will be made with the present system. Then the road will pass through Upper Montclair, Montclair, Bloomfield, Orange, East, West, and South Orange, Maplewood, Wyoming, Springfield, Westfield, Fanwood, and Northwood, to a connection with the present system in Plainfield, and thence through Plainfield to Bound Brook. Crossing the New Jersey Central Railway at Finderne, the road will continue through Hillsboro and Weston, and thence to Millston, Rocky Hill, Princeton, Lawrenceville, and Trenton. Branches will run from Bound Brook to New Brunswick, Somerville, and Raritan; from Bloomfield to Irvington, and to Morristown, *via* Chatham and Madison. At Irvington connections will be made with the existing lines, making a direct route to Newark and Jersey City. From Westfield the road will run to Rahway, connecting there with the line to Lebanon and Boynton, South Beach, Woodbridge, and Perth Amboy. From Rahway the line will go to

Elizabeth, and a branch will connect Bound Brook with New Brunswick. From Trenton, the road will pass through Morrisville, Bristol, Cornwells, Terresdale, Tacony, Holmesburg, and Frankfort, and thence into Philadelphia."

The commercial and social relations between these towns (some of them large and all prosperous) and the terminal cities is so close that they may almost all be regarded as suburban with reference to New York or Philadelphia. From all of them numbers of business men go to the terminal cities each morning and return at night, and most of them have large manufacturing industries with head-quarters at one or the other terminals. The bulk of their family shopping is also divided between the larger cities, and the daily traffic between New York and Philadelphia is very great. The conditions are, therefore, very favorable to success.

A German Air-Pump.

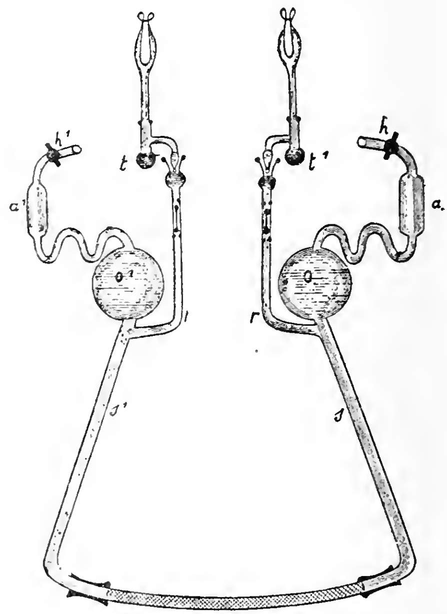
THIS form of double-acting mercury air-pump was designed by W. Bähr and E. A. Krüger, of Berlin. It appears to be an improvement upon preëxisting forms, and it is public property, not being patented. It operates twice as fast as the ordinary mercury pumps. *The Electrical Engineer* (Aug. 26) has an engraving and a description of the invention, extracted from a German source. From it we make the following abstract:

Two Tüpler pumps whose riser tubes, *s s'*, are only 40 cms. long, are connected by a rubber tube at their lower ends. The pump is mounted on a board so that the bulbs, *o' o*, are in the position shown.

The usual barometric tube is dispensed with, and immediately above the air accumulators, *a' a*, there is placed a glass cock; no other change is made in the pump. The board on which the pump is mounted is arranged so that it can turn upon a central horizontal axis, the motion on each side being limited by stops.

The pump is supplied with mercury, until the bulbs, *o o'*, are filled about one-half; the two cocks, *h h'*, are connected to a preliminary pump. The vessel to be exhausted is connected to the drying bulbs, *t t'*, and the preliminary pump set in action; by opening the cocks, *h h'*, the greater quantity of air is removed. Since the air is removed from both sides, the level of the mercury remains constant.

If now the board be turned on its axis, a difference in level ensues, the mercury in the bulb, *o*, falls below the tube, *r'*, connected with the vessel to be exhausted, while on the other side it forces the air through the accumulator, *a'*, where it is removed by the preliminary pump. On turning the board in the opposite direction, the same action is repeated, the mercury now falling in *o'*, and rising in *o*. The air is prevented from rushing back by the action of the bent capillary tubes, which retain the mercury. The oscillation of the board is continued until the mercury in the bulb touches the mercury thread in the M shaped capillary tube,—that is, until it shows no air-space between them. With this combination one pump alternately serves as the mercury reservoir for the other, and its movement is fully utilized. With ordinary pumps the falling of the mercury must always be awaited before a fresh exhaustion can take place. The oscillation is a slow one, and hence breakage is almost completely prevented.



DOUBLE ACTING MERCURY AIR-PUMP.

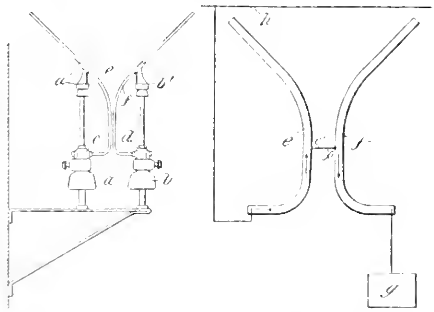
A German Lightning Arrester.

THE ELECTRICAL ENGINEER, from which we have reproduced on a smaller scale the accompanying engraving and have condensed the description of this lightning-arrester, says the efficiency and certainty of its action for currents of high voltage have been practically demonstrated. It is not likely to get out of order, as none of its parts are movable, and its construction is very simple. Placed out of doors, under a hood, it does its work without further attention.

The instrument, ready for use, is shown at the left of the engraving. At the right hand is a diagram referred to in the description.

The metallic caps, *c* and *d*, support the uprights, *e* and *f*, and are themselves supported by insulators, *a* and *b*. The caps are respectively connected to the circuit and the ground. The uprights are adjustable in the caps to distances from each other corresponding with the voltages of different circuits. The uprights rise parallel to each other for a short distance, and then widely diverge, the divergent branches resting upon insulators, *a'* and *b'*. The uprights are copper rods, and are similar in form.

Referring now to the diagram, at the right of the engraving it is evident that " a discharge of lightning will arc across the narrow space separating the uprights and be conducted to ground. Should the arc persist, it will quickly travel upward between the diverging uprights, *e f*, until lengthened sufficiently to destroy it. This extinguishment of the arc is the result of thermal and electrodynamic actions. When the arc is established, as at *e' f'*, the surrounding air is rapidly heated, causing an upward current of air at that point, which tends to carry the arc with it. In addition to this cause, it is well known that conductors under the influence of an electric current tend to arrange themselves in parallel positions. The arc, *e' f'*, being practically at right angles with uprights, the portion *e'* tends to assume the position of the upright *e*, and acts with the upward current of air in lifting the arc. Similarly the portion *f'* tends to assume the position of upright *f*. Thus any arc which may be formed between the uprights is quickly raised to their divergent portions, and thereby becomes self-ex-



OELSCHLAGER AND SCHROETKI'S LIGHTNING ARRESTER.

tinguishing, both the above-mentioned causes, the thermodynamic and the electrodynamic, coacting to drive the arc upward and extinguish it.

" It is evident that the maximum effect is secured when the thermodynamic influence acts with the electrodynamic to drive the arc upward. This, however, can only be accomplished when the uprights are electrically connected with the circuit and ground, so that the arc is the uppermost part of the path of the current which is flowing. The connections should, therefore, be made at the lower ends of the uprights, for, if they are made above the arc, the electrodynamic would act in opposition to the thermodynamic force."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

7604. Novel Features of the Niagara Falls Lighting Plant. Orrin E. Dunlap (Illustrated description). W Elec-Aug 15. 1300 w.

7605. Incidental Points About a Central Station Plant. By a Superintendent (Suggestions upon central station management). W Elec-Aug 15. 1200 w.

*7622. The Use and Economies of Rectifiers for Arc Lighting. John Hesketh (Abstract of a paper read before the Northern Society of Elec. Engs. Inefficiencies of present arc-lighting systems). Elect'n-Aug 7. 3000 w.

*7623. Electric Lighting in Belfast. Victor A. H. McCowen (Abstract of paper read before the Inst. of Mech. Engs., at Belfast. An exhaustive description of the plant, distribution, gas-engine, power, etc., with some data and discussion). Elect'n–Aug 7. 6800 w.

7628. The Detroit Municipal Street Electric Lighting Plant (Information abstracted from the report of the Public Lighting Commission). Eng News–Aug 13. 1400 w.

*7638. Equalizer Systems of Distribution (Editorial dealing with the present state of the art in the matter of distribution, and what has been proposed with reference to equalizers and compensators or balancers). Elec Rev, Lond–Aug 7. 800 w.

*7640. New Lamps for Old (Illustrated description of an improved glow lamp, with experimental data obtained from a report by Mr. George Annesley Grundle). Elec Rev, Lond–Aug 7. 2200 w.

*7681. Combined Alternating and Continuous Currents. Alexander Russell (Some singular effects that follow the super-position of a direct upon an alternating current and *vice versa*). Elect'n–Aug 14. 1300 w.

*7683. Extensions to Outlying Districts. A. H. Gibbings (Extensions as related to cost and revenue are discussed, and also the advisability of such extensions). Elect'n–Aug 14. 3000 w.

*7693. American Experience with High Voltage Lamps (Review of progress and present status of high voltage lamps in the United States). Elec Rev, Lond–Aug 14. 800 w.

7714. A Modern Village Lighting Plant—Norwood, Ohio. Thomas G. Smith, Jr. (Description of one of the latest installations operating incandescent lamps for street-lighting, by direct constant potential current). Elec Eng–Aug 19. 1000 w.

7782. A Direct-Coupled Gas Engine and Dynamo (Illustrated description). Eng Rec–Aug 22. 450 w.

7794. High-Voltage Incandescent Lighting (Reports from a number of central stations and lighting plants using 220-volt lamps). Am Elect'n–Aug. 1400 w.

†7877. Standards of Light. Edward L. Nichols, Clayton H. Sharp, and Charles P. Matthews (An admirable piece of work, both in style and subject matter. The report represents great labor, by which the unreliability of standards in use is affirmed, and the desirability of a standard consisting of an electrically heated incandescent surface is exhibited. The committee also reports that it is engaged in experiments looking toward the solution of the difficult problem of definition of degree of incandescence of heated carbon, hoping thereby to reach the desired standard. Discussion follows). Trans Am Inst of Elec Engs–April. 23500 w.

7973. The Light of the Future. E. Hospitalier (The ideal light—light with the minimum of heat. The author thinks we are approaching the realization of this ideal). Pro Age–Sept. 1. 700 w.

7981. Electric Lighting of Railway Trains Abroad (Reprint from the *Car*. A short account of the development of this branch of electric installation work). Sci Am Sup–Sept. 5. 2000 w.

*8000. Electric Lighting in Australia. Henry J. Spencer (A brief review of electric lighting matters,—which are not very largely developed in Australia). Elect'n–Aug. 21. 3000 w.

8029. Electrical Plant of the Duquesne Steel Works and Blast Furnaces (Describes the power house, generators, switchboards, plant, etc). Elec Eng–Sept. 2. 2200 w.

†8061. A Complete Test of Modern American Transformers of Moderate Capacities. Arthur Hillyer Ford, with introductory note by Dugald C. Jackson (Complete results of Mr. Ford's transformer tests, which represent the product of all the American makers except two). Bul of Univ of Wis–Vol 2, No 1. 7000 w.

8081. The Cleveland Electric Illuminating Company (Presents the chief features to be found in this plant, with illustrations). Elec Wld–Sept. 5. 1400 w.

*8088. Central Station Extensions. G. L. Addenbrooke (A further consideration of the subject in reply to articles by Mr. Barnard and Mr. Baynes, and outlining facts of interest). Elec Rev, Lond–Aug. 28. 2300 w.

Power.

7582. The Electric Wagon on the Farm (Description, with two elevations, of an electric traction engine for plowing and general farm work, the product of the inventive skill of O. W. Ketchum, of Baltimore, Md). Can Eng–Aug. 1000 w.

7590. Transmission at Rheinfelden. E. Rathnan (Abstract of a paper read before the Verband Deutsch Elektrotechn. Illustrated description). Elec Eng–Aug. 12. 900 w.

7601. Controlling Devices for Series-Wound, Constant Potential, Electric Motors. William Baxter, Jr. (Illustrated description of the principles involved in the construction and operation). Am Mach–Aug. 13. 1800 w.

*7621. Energy Losses in Electric Machines Due to the Armature Current. Otto T. Blathy (Detailed results of recent experiments on the load-loss of a typical dynamo). Elect'n–Aug. 7. 400 w.

7667. The Hamburg Combined Electric Power Station (Illustrated detailed description). Eng Rec–Aug. 15. 1500 w.

7728. On the Use of Small Electric Motors. N. S. Stevenson (An excellent practical article of value to purchasers of small electric motors). Am Mach–Aug. 20. 1700 w.

7793. Alternating Current Motors. Dugald C. Jackson (Abstract of a paper read before the Northwestern Electrical Association, in July, with data and curves of tests of polyphase motors). Am Elect'n–Aug. 1500 w.

7836. Starting Box with Under-Load and Over-Load Circuit Breaker (Illustrated description of a needed device). Am Mach–Aug. 27. 800 w.

7849. The Electrical Plant of the Syndicate Building, New York (Illustrated description of the light and power service, operated on the same 110-volt circuit). Elec Wld–Aug. 29. 2400 w.

7934. How to Make a Simple Dynamo. S. L. Barriett (Illustrated description with full directions). Power–Sept. 2800 w.

*7943. The Utilization of Water Power. Alph. Steiger (Abstract of paper read before the Inst. of Elec. Engrs. The great service water powers are capable of rendering in the cheap production of electrical energy, with description of a few turbine plants under low falls). Prac Eng–Aug. 21. Serial. 1st part. 1600 w.

8027. Why the Armature of An Electric Motor Revolves. D. L. Barnes (From the Baldwin-Westinghouse catalogue of electric locomotives. Explanation of the cause of the movement). Elec Rev–Sept. 2. 2500 w.

8028. The Big Cottonwood Power Transmission, Utah (Illustrated description). Elec Eng–Sept. 2. 1600 w.

8079. On the Seat of the Electro-Dynamic Force in Ironclad Armatures. Townsend Wolcott (Theoretical consideration of the question advanced by Messrs. Houston and Kennelly in a previous article). Elec Wld–Sept. 5. 1200 w.

8090. Transformers. G. W. F. (A study of the apparatus and the principles governing its action, with the electrical, magnetic and mechanical features of the design and construction). Can Elec News–Sept. Serial. 1st part. 2500 w.

*8092. A Non-Synchronous Two Phase Alternate Current Motor. Ernest Wilson (Experiments with the object of investigating the currents in the armature conductors and their effects upon the magnetic field of the motor). Elect'n–Aug. 28. 2500 w.

8115 The Testing Department of the General Electric Company's Works. Theo. Straus (Illustrated description). Elec Eng–Sept. 9. Serial. 1st part. 1500 w.

Telephony and Telegraphy.

*7680. The Apostoloff Automatic Telephone (General description of an invention designed to supersede the special telephone operator and permit the subscriber to control cross connections at the central exchange). Elec Eng, Lond –Aug. 14. 1200 w.

*7688. Telephonic Communication Between Light-Vessels and the Shore. Charles A. Stevenson (General description and remarks upon Prof. Blake's apparatus and system, declared to be efficient). Elec Rev, Lond–Aug. 14. 1000 w.

7804. The Gebrueder Naglo Equipment of Telephone Exchanges—System Hess-Roverot-West. Jul. H. West (Illustrated detailed description of this new French system of connections for central stations on the principle of arithmetical combinations. From advance proof sheets of the *Electrotechnische Zeitschrift*). Elec Wld–Aug. 22. 4800 w.

7807. Improved Telephone Switchboard (Illustrated description of invention of Edward L. French). Elec Wld–Aug. 22. 275 w.

7996. Telephone Cables. Dr. V. Weitlisbach (The article deals with talking through cables and cable construction. The difficulties and how to overcome them). Elec Engng–Sept. 3700 w.

7997. The Air-Drying Process for Telephone Cables. Dr. V. Wietlisbach (Principles of the process, method, plant, apparatus, &c). Elec Engng–Sept. 2000 w.

Miscellany.

*7569. The Shifting Lines of Industrial Interest in Electricity. George Herbert Stockbridge (Tracing electrical evolution, from the lightning rod, through the voltaic pile, to the telegraph, the telephone, and electrical transmission of power). Eng Mag–Sept. 4200 w.

7585. Wire Insulation. H. W. Nelson (Remarks calling attention to a backward branch of electrical work, with suggestions for improvement). Can Elec News–Aug. 1100 w.

7586. Improvements in Thermo-Electric Batteries. James Asher (Methods devised by the writer, for securing good economy in the Clamond type of thermo-electric, which uses no water and which has a chimney). Elec Rev–Aug 12. 1700 w.

7589. On the Proper Use of Safety Fuses and Magnetic Circuit Breakers. William Baxter, Jr. (Discusses the proper place for blow-out fuses, and shows that they are not necessary in the main circuits of central stations and isolated plants). Elec Eng–Aug 12. 1500 w.

7591. Therapeutical Effects of Currents of High Frequency. A. d'Arsonval (From *L'Industrie Electrique*. Preliminary report of some very exact experiments which are being undertaken in Paris, and which promise results of great value). Elec Eng–Aug 12. 1200 w.

*7607. Some Notes on Electrotyping, Plating and Gilding. J. Warren (Hints for the guidance of amateurs and learners). Elec, Lond–July 31. 2300 w.

*7620. Dispersion. Oliver Heaviside (An inquiry into some obscurities and inconsistencies which the author finds in Helmholtz's theory). Elect'n-Aug. 7. 2800 w.

*7659. The International Congress of Electricians in Geneva (Editorial, reviewing the principal features of this congress, opened Aug. 4, and introductory to a full review of the proceedings). Engng–Aug. 7. 1800 w.

*7684. The Electrical Transformation of the Energy of Carbon (An editorial review of the attempts, failures, and partial successes in this field of invention). Elect'n–Aug. 14. 1200 w.

*7689. Analysis of Transformer Curves. W. G. Rhodes (Mathematical analysis of curves obtained by C. K. Huguet of Tulane University). Elec Rev, Lond–Aug. 14. 700 w.

*7690. The Seat of Electro-Dynamic Force (Account of, and remarks upon experiments performed by Houston and Kennelly). Elec Rev, Lond–Aug. 14. 1000 w.

*7691. Lighting Circuits for Electro-Therapeutic Requirements. E. Meylan, in *Revue Internationale de l'Electricité* (A universal transformer for alternating current. Illustrated description with prefatory remarks upon requirements for the utilization of electricity in therapeutics). Elec Rev, Lond–Aug. 14. 2100 w.

7712. Electrical Features of the Geneva Exposition (Illustrated description). Elec Eng–Aug. 19. 1900 w.

7758. Electric Furnaces and the Conversion of Carbon into Graphite. Translated from *Le Genie Civil* (Review of the principal models of electric furnaces, with illustrations). Sci Am Sup–Aug. 22. 2600 w.

7759. Lightning Arresters. W. R. Garton (Read before the Northwestern Electrical Assn. A general dissertation upon the principles and different forms of lightning arresters). Elec Rev–Aug. 19. 2800 w.

7775. Some Electrical Features of the United States Battleship "Indiana" (Illustrated detailed description). Elec Wld–Aug. 15. 2300 w.

7788. Electricity in the United States Navy. Frank W. Roller (Consists chiefly of illustrated descriptions of marine electrical appliances). Am Elect'n–Aug. 2500 w.

7789. Transformer "Leakage Current." Dugald C. Jackson (Leakage current no longer a criterion of losses in transformers. Data and directions for testing transformers are appended). Am Elect'n–Aug. 1400 w.

7790. On Röntgen Ray Apparatus Operated from Alternating Current Circuits. Edwin J. Houston and A. E. Kennelly (Illustrated description of a method whereby excellent results may be obtained from an alternating-current incandescent-lighting circuit, the recharging of cells being in this way obviated). Am Elect'n–Aug. 1100 w.

7792. Modern Armature Windings and Connections. Cecil P. Poole (The general principles that govern all armature windings being first enunciated, the author gives illustrated descriptions of modern armature windings). Am Elect'n–Aug. 2000 w.

7795. Construction of a Tesla-Thomson High Frequency Coil. A. F. McKissick (Illustrated description). Am Elect'n–Aug. 600 w.

7796. Interior Wiring (Switch control in buildings is the topic discussed. Faults in position are pointed out and proper methods described. Diagrams illustrate the text). Am Elect'n–Aug. 1600 w.

7797. Faults in Dynamos (Mistakes in armature connections are illustrated by diagrams and described in the text). Am Elect'n–Aug. 1400 w.

7801. A Biographical History of Electricity (Franklin's work is reviewed). Am Elect'n–Aug. 1300 w.

7810. Electrical Bottle-filling Machine (Illustrated description). W Elec–Aug. 22. 1100 w.

7811. Electrical Equipment of the University of Wisconsin (Illustrated description). W Elec–Aug. 22. 1800 w.

7819. Statistics of the Association of the Elektricitaets-werken for the Fiscal Year 1894–95 (This extensive table gives the names of the principal European cities wherein electric installations have been placed, with their population, name of the electricity works, character of management,—municipal or private,—date of starting works, system of current distribution, charges for light and other uses, with statement of the municipal or private management of gas lighting, if used, in each city). Elec–Aug. 26.

7848. On the Multiplicity of Brushes in Large Generators. William Baxter, Jr. (Favors the employment of the two-brush machine, as a substitute for multiple brush machines, with reasons for the preference). Elec Wld–Aug. 29. 1700 w.

7850. An Apparatus for Testing the Magnetic Permeability and Hysteresis of Iron (Illustrated description of apparatus exhibited by Professors Ayrton and Mather at the Royal Society *Soirée*, June 10). Elec Wld–Aug. 29. 900 w.

7972. A Few Points in Relation to the Construction of Commutators. F. J. Turner (Directions illustrated by diagrams). Am Mach–Sept. 3. Serial. 1st part. 1200 w.

7980. The Quantitative Analysis of Metals by Electrolysis (Illustrated description of Riche's electrolytic apparatus and Classen's electrolytic apparatus, with precautions necessary for carrying on the operation successfully). Sci Am Sup–Sept. 5. 800 w.

*7999. The Cox Thermo-Electric Generator (A brief review of work in this field. with description of Mr. Cox's invention). Elec Rev, Lond–Aug. 21. 2000 w.

†8024. An Analysis of Transformer Curves. Charles K. Huguet (Experimental investigations conducted by the writer in Tulane University, with discussion). Trans Am Inst of Elec Engs–May. 4800 w.

8080. The Load Losses Produced by Armature Currents. Harris J. Ryan (Claiming knowledge, since 1894, of the load losses recently discussed in paper by Mr. Bláthy). Elec Wld–Sept. 5. 900 w.

8084. A Contribution to the History of Electrolysis of Alkaline Chlorides. George Lunge (Discussing the question whether the priority of actual success in this field belongs to Germany or to England). Eng & Min Jour–Sept. 5. 2500 w.

*8087. Lightning Protecting Devices for Heavy Current Installations (Contributions from various electrotechnical societies to the question how heavy current installations can be protected from the danger of lightning. Experience of German institutions). Elec Rev, Lond–Aug. 28. Serial. 1st part. 1300 w.

*8093. The Standard Mercury Ohm of the Physikalisch-Technische Reichsanstalt. Wilhelm Jaeger (A summary of investigations undertaken with a view toward the preparation of legal mercury standards of electrical resistance for Germany). Elect'n–Aug. 28. 4000 w.

8107. Liberality of Mind Among Electrical Engineers. R. D. Williams (Charges a spirit of illiberality against electrical engineers as a class, and in the matter of imparting information). Am Mach–Sept. 10. 900 w.

8116. The Manufacture of Chemicals by Niagara Power. Orrin E. Dunlap (Description of plant and processes of the Chemical Construction Company). Elec Eng–Sept. 9. 1500 w.

INDUSTRIAL SOCIOLOGY

An Industrial Democracy.

WE have found the perusal of an article by C. R. Richards, in *Pratt Institute Monthly*, so interesting that we feel it ought to be mentioned in these reviews. The article is too long to be reprinted, and we must be content with an abstract of it. It is a description of the industrial organization in the works of the National Cash Register Company, Dayton, Ohio, which appears to amply justify the title of the article.

"One of the first steps" in organizing the working force in the factory "was to replace the superintendent by a committee of five heads of departments, upon whom the responsibility of the factory management was placed. This principle was afterward extended to sub-committees of foremen and sub-foremen, upon each of whom the largest possible amount of responsibility and initiative was placed, and who to a large extent settled all matters within their own immediate province. These different committees are very similar in their functions to congress and the State legislatures, the head committee making rules and effecting decisions which serve for the guidance of the entire establishment, and the minor committees having jurisdiction within their special domains.

"To extend still further the principle of individual initiative, an autographic register is placed in every department of the factory, on which the employees are invited to write suggestions or criticisms that may be of service in the conduct of the business. For the best suggestions prizes are awarded. Last year these amounted to six hundred dollars. To each one of the prize-winners a diploma of award is given, and his name is added to a permanent roll of honor which hangs in a conspicuous place in the main factory building. The presentation of these prizes is always an occasion of some importance. All the employees are gathered together, and speeches are made by the officers of the company. From this system of awards have been gained substantial advantages. Many of the suggestions so secured have proved of direct financial benefit to the company, in the way of either lessening the cost of manufacture or improving the construction of the machines. The plan has encouraged the men to read, observe, and think, and has been a beneficial influence in educating and broadening them.

"The payment of high wages is also an integral part of this system of individual incentive; for the company have found that nearly all workmen increase their daily output when sure of an increased return. In this way the entire establishment has been converted from a mass of more or less irresponsible workers into a hive of workers and thinkers, each one of whom is inspired with the effort to benefit his own position by benefiting the company." The result has been a notable improvement in quantity and quality of production. But there are other notable and interesting innovations. The employees of both sexes are taught how to take care of their health, by oral instruction, and by a semi-monthly paper published by the concern. Twice a day all hands take a course of calisthenic exercise. Baths are supplied, and each employee may bathe once a week in the company's time. The women are permitted to commence work an hour later in the morning than the men, and to leave fifteen minutes earlier at night. At the time of the calisthenic exercises in the middle of each half-day, they spend five minutes in the exercise, and have, in all, fifteen minutes' recess.

"Every woman employee is also given a half holiday on Saturday, and in addition a whole holiday each month. They work in clean, airy rooms, separated from the men, under forewomen of high character. Rest rooms, furnished with cots, are provided in each department, and clean aprons and sleeves are supplied by the company. Each department has a colored janitress, and at the noon hour hot coffee, tea, and soup or some other nutritious food are furnished to women employees. The average cost of these lunches is about three cents each, and it has been found that, by reason of them, each woman does one-twentieth more work each day. This amounts to five cents apiece, making the gain two cents, or 66⅔ per cent. When this feature was instituted, an instant improvement in the general health of the women was noticed. There were less delays from sickness, fewer absences, and an ability to work harder and more enthusiastically than when they ate cold food."

Instruction in cooking in outside weekly classes is also given to the young women who desire it, the company giving them the necessary tickets.

"One of the rules of the company is to employ no young women who are not graduates of the high school. They have found that, when the hours of labor are shortened and safeguards to health adopted, persons of education and superior mental power are immediately attracted to the work, and it is easier to retain them after they have become skilled. From a purely financial standpoint, they find that the same number of young women turn out more work of a better quality, at a less cost to the company, than was ever done under former conditions. A committee of five of these young women is appointed to take charge of flags, floral decorations, landscape gardening, etc., about the factory."

A training school for members of the selling force, in which each spends a month before entering upon active duty is another unique feature of this altogether unique organization. In reading Mr. Richards' account of it one recalls the divine humanity of Leviticus, XIX, 9, 10, 13. The article closes with an extract from an address delivered by the president of the company before the Present Day Club of Dayton, January 28, which we cannot forbear quoting.

"Our system is the new factory system, and is as great an improvement over the old as the new high school is over the old high school. Under the old system too much merit in an employee was sidetracked before it came to the notice of the officers; the workmen were nearly all eye servants, who did their best only when a foreman was watching, and those who were dull and slow did not get much aid. In the new factory dull ones are awakened to effort by the example of others who were formerly almost as dull as themselves. Our new factory life is an educator which trains workmen to regard the factory as a fine piece of mechanism in which each individual is an important part. The intelligent coöperation required of each person is a powerful aid to good citizenship.

"We were long ago impressed with the idea that many changes should be made in our system, but were timid in taking any new steps. Many prejudices had to be overcome before the strong desire to deal justly with our employees took effect. When we saw that it was not only just, but to our own interest, to adopt a system of mutuality, we gradually made the change. We learned that, in order to gain unusual ends, one must adopt unusual methods.

"We now aim for coöperation and the strength there is in union; and the more we strive for this, the more success we meet. It seems to us, after trying both the old and the new factory system, that in the latter lies the closest realization of the words of Abram S. Hewitt, who said:

"'Beyond all dreams of the golden age will be the splendor, majesty, and happiness of the free peoples when, fulfilling the promises of the ages and the hopes of humanity, they shall learn to make equitable distribution among themselves of the fruit of their common labor.'"

The Autonomy of Labor.

UNDER the above title *The Contemporary Review* for August has a thoughtful paper written by Mr. H. W. Wolff. The recent labor congress indicated the power of organized labor,—a militant power which the author speaks of as "fighting trades unionism." But the positions are taken that this power can be exerted only by those who possess it; that it has not helped, and seemingly cannot help, those who need help most,—that is, "the lower strata" of the industrial community; that "it merely corrects a faulty distribution of profits without adding to the profits to be distributed;" and that "it disturbs, rather than steadies, the movement of the industrial machinery, and sometimes shatters the prize for which it is contending, even in the very act of winning it."

It therefore covers too narrow ground. It has done nothing for unskilled labor. The great army of the "sweated" remains as large as ever, and as "sorely oppressed as ever." This class of workers has not the militant power of organized trades-unionism. It cannot enforce demands by refusing supply. It is "abjectly helpless" in its present condition. Yet Mr. Wolff does not regard its state as hopeless; it still has resources which are pointed out, and illustrated by industrial movements in France and Italy. Of course the "army of the sweated" here specially referred to is the lower laboring population of the United Kingdom; but the examples of improvement effected by organized action in France and Italy are worthy of the consideration of all who, in any land, desire the amelioration of the condition of the humblest toilers.

The cause which produces sweating is the command of excessive power in the hands of an unscrupulous middleman. The truth of this proposition has recently been exemplified in the tailors' strike in New York city. The most natural remedy is the one that reaches the cause, or, as Mr. Wolff puts it, "either to reduce his (the middleman's) power, or else to get rid of him altogether." How this was done in France in one instance is recounted.

"Some humble stone-breakers . . . sweated and very helpless—having neither capital nor a trade union at their back—resolved to endeavor to emancipate themselves from their employer's power. Their employment was to break disused paving stones into macadam for the municipality of Paris, in the pay of a private contractor, who received the contract from the town council, according to a standing usage." For this they received only from three francs to three francs and fifteen centimes per cubic meter out of the five francs and fifteen centimes per cubic meter allowed to the contractor, who thus pocketed forty per cent. of the full price paid by the municipality, without risk or serious work. "The men applied to the municipality for the contract direct," and they got it after careful consideration of their application. They have given full satisfaction, are now awarded the contract triennially, and are receiving two francs per cubic yard—about sixty-six per cent.—more for their work than they did under the middleman's employ.

Clearly, the middleman was in this case of no use, except to himself. The men have now laid by a combined capital which will soon enable them to graduate from stone-breakers into the more profitable trade of road-makers.

This is cited as in striking contrast to the methods of militant trades-unionism. The men "have become their own masters. . . . They can go to bed at night with a quiet mind, secure of their position and their employment. . . . Responsibility, quickened by personal interest, has put them on their mettle. They have become better and more competent men,—something of an aristocracy among their own class. They freely admit new-comers. Poverty need not stand in the way, for a man can easily make up the value of his share out of his earnings. But the new-comer must be trustworthy and respectable. Thus in two ways has this little association become a power for good among its own class of workers. It raises wages and it raises character."

The example has been followed by other associations in the same craft and in kindred crafts. In Italy the same sort of combination has been effective in removing the disabilities of workmen. Interesting instances, which ought to be given wide publicity, are set forth, but we refer readers to the original paper for these. The author concludes with an earnest exhortation to leaders in labor movements to study a system of organization which invites no hostility from communities wherein it has been carried out, but, instead, is greeted with friendly sympathy and cordially welcomed.

The Crime of 1896.

THE first article in *Gunton's Magazine* for September has the above title, a paraphrase of an expression frequently made use of by the advocates of silver. The crime charged is that of an attempt to reduce wages. This reduction of wages would follow free coinage. The sound principle that wages are properly measured only by the amount that can be purchased by them is the basis of this proposition. The names of coin or other representatives of value do not determine their value, which can be proved only by the quantity of merchandise or other property which dealers in the open market are willing to exchange for the coin. Robinson Crusoe, on his desert island, had plenty of money; but all he had could not purchase one thing that he desired. His money was therefore valueless to him, although, counted in the usual way, it was a large sum. If he had been surrounded with merchants offering to sell him everything he wished, he would have been obliged to part with as much of this treasure as they might have been pleased to ask for their wares, and this would have been the proper measure of his wealth, in that market.

The article reviewed starts out with the proposition that "the highest crime against national prosperity is to strike down wages, and the most criminal method of reducing wages (because the most insidious and far-reaching) is to debase the standard money in which wages are paid." Upon this proposition are based the following arguments.

"Against actual reductions of money wages by individual employers or corporations, laborers can have recourse to the ordinary means of economic defence through organized resistance, but against the slaughter of wages through debasing the money laborers receive the methods of organized labor are impotent. The evil comes, not in a reduction in the amount of wages laborers receive, but in a reduction in the amount of welfare the wages will buy. Debasement of the standard money steals from the laborer the substance of his wages without changing the form. It silently increases his poverty without reducing his income. This masked assassination of real wages, like the destroying angel of old, in a single night smites every laborer's household. No other industrial scourge is as universal or as sudden as this. All other forms of industrial disaster follow the lines of certain industries or geographical sections, and are more or less gradual in their coming; but this weapon of poverty strikes every laborer in the land at a single stroke."

No one supposes that wages will rise in advance of the adoption of free coinage, or from the anticipation of an advance in prices effected by the success of the free coinage policy. All history shows that the result will be a general and immediate rise in prices of commodities as measured by silver. As measured by gold, general prices will remain substantially what they are now, barring the ordinary fluctuations. But all history shows that the price of labor remains at a standstill till a notable rise in general prices has been made, and that, thereafter, a lead in prices always remains, against the price of labor. Moreover, history shows that, while the prices of merchandise and other property, immediately rise with the depreciation of the currency, advances in wages are reluctantly yielded by employers, and are secured only by the persistent effort of wage-earners, usually involving severe labor disturbances with their attendant distress. This sort of thing (not the prosperity blindly predicted by the advocates of free silver) is what is to be reasonably anticipated, if the lessons of history, as logically interpreted and applied to the present critical period, are ignored.

The first reduction in wages would probably be not less than forty-nine per cent. For a time this would have to be endured by every skilled workman and by every unskilled laborer in the United States. After a while this percentage would be lessened by advance in wages, but its total obliteration would form an entirely new precedent in industrial history. Nothing in the past justified such an expectation. The scheme (of free coinage at sixteen to one) has not even the "seeming excuse" that it has behind it "an abstract theory of equitable commercial relations." . . . "It has behind it neither history, economic theory, nor financial judgment. It is a scheme whose sole purpose is to strike down wages in order to double the profits of a small and special class. . . . Thus to strike down wages is to destroy nearly half the consuming power of over fifty millions of people, and with it destroy the very basis of prosperity in every form of productive industry. The farmers who are expecting to gain by this sacrifice of the laborers will soon find that the promised profit is a mere mirage. The chief market for the products of American farmers is consumption by the wage and salary-receiving population employed in the manufacturing and commercial industries; let this be reduced fifty per cent., and all hope of improvement for the American farmer is gone. There is no chance for increasing his sales abroad. India, Argentine, Russia, and Austria can beat him there. Let American markets be destroyed, and the abyss of agricultural depression will be at hand, and unsold crops, foreclosed mortgages, deserted farms, and agricultural desperation will be realized.

"Whatever may be the theories of farmers regarding prices, they cannot afford to destroy the markets for their products. Whatever may be the theories of laborers regarding capital, public ownership of industries, or the reconstruction of society, they cannot afford, under any circumstances, to permit a wholesale reduction of wages."

The Philadelphia Commercial Museum.

AMONG the important organized efforts to extend the foreign trade of the United States the institution named in the title merits attention. While its benefits must in their nature be of national extent, the enterprise is supported by Philadelphia, which has thus initiated a work from which the commerce of other cities will gratuitously profit. In this institution will be studied the foreign commerce of all lands, and extensive data will soon be acquired and placed at the command of all the industrial interests of the country. To this end arrangements have been made for constant communication with all export markets and for the collection, preservation, and exhibition of samples of products from all parts of the world.

The Manufacturer's Record (Aug. 14) details the purposes of the bureau, an important function of which will be "to advise concerning the commerce of all countries, their customs and commercial relations, their international treaties, their systems of communication and transportation, with special details of freight lists and tariffs, exchanges and currency. It is the purpose of this department to be sufficiently broad in its scope to command the good will and coöperation of all manufacturers, bankers, commission houses, transportation companies, and all others interested in the development of our foreign trade.

"The manufacturer or dealer who desires to import the raw products of foreign countries, such as woods, hides, skins, food products, etc., will be shown the samples in the museum, and, through this bureau, will be advised as to the prevailing prices in the country of origin, the means and cost of transportation, quantity available, and conditions under which the particular products desired can be procured.

"The manufacturer who wishes to introduce his goods into new markets abroad will be shown samples of whatever is now salable in those markets. Full details as to the competition he may have to meet will be furnished him as follows:

"(1) Character and variety of goods demanded in various markets; (2) the country from which imported, together with the names and addresses of foreign manufacturers, where possible; (3) the quantity imported annually into each particular city; (4) the manufacturers' prices at the factory; (5) the retail prices in each city where sold; (6) transportation charges from Europe to the various foreign ports, compared with rates from the United States; (7) import duties; (8) character of packing; (9) the names and addresses of importers.

"The bureau will also collect detailed information concerning all public improvements in progress or contemplated in Spanish America, South America, and other new export fields, which may be of interest to the commercial classes of the United States.

"A commercial library will be maintained, consisting of statistical publications of our own and foreign countries, maps, charts, and all prominent trade publications of the world; also official copies of the import and export duties of all foreign countries."

Emigrant Agencies.

THESE agencies are denounced by *The Board of Trade Journal* for August as "a special snare to intending (English) emigrants." Many abuses are constantly coming to the knowledge of the emigrants' information office, mainly in connection with what is called the "farm pupil premium system." Under this system certain agencies are said to have become notorious. They undertake to find situations for young men on Canadian farms, and on farms in the United States, receiving for their *quasi* services specified fees, which "are in all cases unnecessary, and in some cases simply fraudulent." The evil has grown to such dimensions that the Canadian press has commented severely upon it, and the Canadian steamship companies have severed their connection with these agencies. This action on the part of the steamship lines is perhaps creditable, but, as they must have previously known the character of the agencies, it would have been more to their credit to have severed the connection before the public exposure of the frauds. No doubt this will fail to much embarrass the agencies, which can easily transport their victims *via* United States ports, at somewhat greater expense. The *Board of Trade Journal* says that "the evil is hard to deal with, for there is no reason to impugn the good faith of many companies of this kind, and in other cases absolute proof of a criminal offence, such as fraud or obtaining money under false pretence, is rarely forthcoming. The quotation below illustrates the abuses which the system fosters. It refers to a party of young emigrants who were induced by one of these agencies to go out to Kansas, in company with some who stopped in Canada, those who remained in Canada having paid a fee of £25, while those who went further fared worse, having paid an agency fee of £45. These fees include their fares to Toronto, *via* Montreal, leaving in the hands of the agency about seventy-two dollars for which it gives no real consideration. Yet there is a pretence of service which the following quotation explains.

"Each young man pays to an agency for service in placing them on a farm to work, the same as farmers' sons, on the following terms:

"The first six months for nothing, the next twelve months for five dollars a month, and then for what they are able to obtain. The young men have had to pay their hotel expenses during their journey. They are of the better class, and several very well educated.

"In nearly all cases the young men are grievously disappointed, expecting to be placed on first-class farms, which, however, is seldom done, the farms allotted to them having very poor accommodation, and consequently they eventually drift back to the cities, where they fail to find employment, and thus swell the already large numbers of distressed British subjects."

The following is from a recently-published report of the British vice-consul at Kansas City:

"During 1895 over sixty young men were sent into this vice-consular district under false pretences from Great Britain; in every case they came through unreliable employment agencies in London; they were sent here under the pretext of their being apprenticed on large stock farms, for which they paid money in advance. After arrival here they were placed on small farms, and in some cases not provided with work, but left to the mercy of strangers, which forced them to seek advice and assistance from the vice-consul. Such employment agencies should be investigated and suppressed."

When the depressed state of the farming interest in the United States is recalled, it is evident that the misrepresentations which induce young men to come here to engage in farming must be shamefully gross.

Rights and Duties.

J. S. MACKENZIE in *International Journal of Ethics* says that man at least is a teleological animal, guided by the idea of an end; and the struggle is more for *rights* than for *existence*. Consciousness of justice is one of the most important elements in making a people strong. Man struggles partly to live, but much more to live well, which means to develop an infinity of relations with the world. The ethical end is best described as the realization of a rational universe. There is no other injustice than to be balked in efforts towards the full development of capabilities by any other cause than the limitations of nature or the claim of other men to a similar development. When the objects to which we relate ourselves are other human beings, we have a right to certain services from them, they have a corresponding right to services from us. From our standpoint, the former are rights, the latter duties. A claim which any individual possesses may be regarded as conveying with it an obligation upon that individual himself. Rights and duties are two aspects of our powers, but they depend not only on our own powers, but on the nature of the things to which our powers are related. The power of ruling gives no right, if there is nothing that wants to be ruled over. There are no natural rights or duties. They are progressive in nature. No man can leap to the goal of human perfection singly. He must take the world with him; and the world moves slowly. making the stages of its advance by establishing definite laws and customs. If these are taken merely as representing the solid part of what has hitherto been done, we may use it as a basis for further work. In criticising rights, and obligations, it should be presupposed that the world is not altogether a fool. Little that is found in law or morals which have stood the strain of centuries of human activity is without some firm foundation in the nature of man.

MALLOCK, the English essayist, combats Hobson's assertion that poverty is on the increase. He holds that the incomes of the poor have constantly increased ever since the establishment of the capitalistic régime, and that incomes of both poor and rich have grown faster than individual riches.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*7563. Free Silver Poison the Cause of Industrial Paralysis. J. Selwin Tait (Showing how debasement of the coinage would affect the savings bank depositor, the shareholder in building associations, the members of insurance companies, and the farmers). Eng Mag-Sept. 3300 w.

†7575. The Autonomy of Labor. Henry W. Wolff (The Italian labor organizations are, among other European societies, shown to have been most effective in good results. Descriptions of some of the principal societies and their operations are given). Contemporary Rev-Aug. 7500 w.

7630. Exporting American Manufacturers (Description of the plans of operation of three different organizations for promoting American commerce abroad; namely, The Exporters Association of America, the National Association of Manufacturers, and the Philadelphia Museum). Eng News-Aug. 13. 3500 w.

7636. Some Historical Facts as to Protection (Editorial argument for the protection of American industry by a customs tariff). Mfrs Rec-Aug. 14. 1700 w.

7637. An Important Work in Finding Foreign Markets for American Manufactured Products (The character of the Philadelphia Museum, its purposes and methods). Mfrs Rec-Aug. 14. 400 w.

*7744. Dangerous Trades (Editorial review of the report of a committee of the British Home Office, showing that the amelioration of the dangers to health incurred in various trades. is a matter of national importance in its relation to the physique of future generations). Engng-Aug. 14. 1500 w.

7787. Municipal Ownership. John A. Britton (Municipal ownership is treated adversely and considered as a disease upon the body politic. Discussion). Am Gas Lgt Jour-Aug. 24. 6000 w.

†7864. Convict Labor (Account of an investigation by the Dept. of Labor, made with a view of bringing recent facts relating to convict labor into comparison with those collected in 1886. Valuable statistics). Bul of Dept of Labor-July. 9000 w.

†7865. Recent Reports of State Bureaus of Labor Statistics (Abstracts of reports for the states of Maryland, Michigan, North Carolina and Massachusetts). Bul of Dept of Labor–July. 2400 w.

†7866. Recent Foreign Statistical Publications (General review of European statistical literature for current month). Bul of Dept of Labor–July. 3500 w.

†7873. Bi-metallism and the Nature of Money. W. H. Mallock (The difficulty with which the bi-metallists have set themselves to contend is herein explained, with the aid of simple diagrams). Fortnightly Rev – Aug. 7000 w.

†7880. From a Silver to a Gold Standard in British Honduras. Alfred Moloney (The beneficial effects produced by the change from stlver to a gold currency in the country named are clearly stated). N Amer Rev–Sept. 3000 w.

†7881. Are the Farmers Populists? John M. Stahl (The question is answered negatively, and the history of the United States is cited to sustain the answer). N Amer Rev–Sept. 4500 w.

*7902. Warning to Intending Emigrants (Issued by the Emigrant's Information Office. Discredits the English emigration agencies and land companies, which, while they confine their operations within legal bounds, are said to obtain large amounts from emigrants for which no equivalent in service is given). Bd of Tr Jour–Aug 1500 w.

*7903. Customs Tariff of British Guiana (Rates now levied on imports into this colony, and list of articles exempt from duty). Bd of Tr Jour–Aug. 1700 w.

*7904. Tariff Changes and Customs Regulations (Russia, Norway, Germany, Belgium, France, Madagascar, Spain, Roumania. Italy, Austria Hungary, United States, Mexico, Costa Rica, United States of Colombia, Brazil, Uruguay, Argentina, Chile, British India and Canada). Bd of Tr Jour–Aug. 5400 w-

7979. An Industrial Democracy. C. R. Richards, in *Pratt Institute Monthly* (Describes an interesting industrial system in operation in the works of the National Cash Register Co. at Dayton, Ohio). Sci Am Sup–Sept. 5. 2200 w.

8014.—$1. Uncertainty as a Factor in Production. E. A. Ross (The causes of uncertainty and the range of variation in the output of many industries, with their social and economic effects). An Am Acad–Sept. 9000 w.

*8018. Fallacies About Gold and Silver (The assertion that silver has not decreased in value per ounce but that gold has risen, one of the most difficult points in the present discussion to deal with, and susceptible of ambiguity on either point of view, is ably refuted). Gunton's Mag–Sept. 4000 w.

*8019. Macaulay on American Institutions (Macaulay's famous prediction as contained in a letter (1857) to Hon. Henry S. Randall (letter reprinted) is here made the subject of editorial comment. The prediction is held to be verified in this year's political situation in the United States; but the cause assigned by Macaulay is held not to be the right one. Freedom alone is not sufficient to make a nation prosperous, happy and intelligent. The conditions of industrial prosperity and social progress must also be wisely guarded). Gunton's Mag–Sept. 2500 w.

*8025. An Outlook Upon the Agrarian Propaganda in the West. Newell Dwight Hillis (The author thinks the present industrial depression is explained by other causes than the appreciation of silver. The rise and progress of sectional feeling, based upon the belief that demonetization of silver is the cause, is reviewed). Rev of Rev Sept. 1800 w.

*8026. Would American Free-Coinage Double the Price of Silver in the Markets of the World? I. The Affirmative View. Dr. Charles B. Spahr. II. The Negative View. Prof. J. Laurence Laughlin (A symposium. Part first considers the effect of free coinage of silver by the United States upon the gold price of silver bullion. Part second replies to Dr. Spahr, pointing out discrepancies). Rev of Rev–Sept. 5000 w.

8035. German Export Methods (Review of a new book—"Made in Germany"—describing German methods, their results and their relations to the extension of American commerce). Eng News–Sept. 3. 1900 w.

*8056. Are We Becoming a Homeless Nation? John O. Yeiser (Reference to numerous authorities, including the census of 1890, leads to the conclusion that only 7½% of the people of the United States own the land on which they live). Arena–July. 2200 w.

*8057. Is the West Discontented? Is a Revolution at Hand? John E. Bennett (Reply to an article by J. H. Canfield, the present chancellor of the University of Nebraska, entitled, "Is the West Discontented? A Study of Local Facts." Mr. Bennett refutes the optimistic conclusions of Mr. Canfield). Arena–Aug. 5500 w.

*8058. Associated Effort and Its Influence on Human Progress. Dr. M. L. Holbrook (Association is the basis of social evolution. The proposition is supported and illustrated by examples in the animal and vegetable worlds. This is followed by instances of successful co-operation in human society). Arena–Aug. 7000 w.

*8059. A Remarkable Statistical Report. James Malcolm (Review and summary of a statistical report on taxation issued by the Illinois Bureau of Labor Statistics). Arena–Sept. 2500 w.

†8103. Some Social Economic Problems. Clare de Graffenried (A general review of problems relating to the betterment of the condition of working classes). Am Jour of Soc–Sept. 4500 w.

†8104. The Criterion of Distributive Justice. Frank Chapman Sharp (The aim of this paper is to present such data as may place the reader in position to decide between two criteria of justice: (1). The rightness or wrongness of every action is determined by the relation in which it stands to the well-being of those directly or indirectly affected by it; (2). Reward should be proportioned to individual desert). Am Jour of Soc–Sept. 4200 w.

MARINE ENGINEERING

Inland Navigation in Germany.

ONE of the features of the times is the notable increase of inland navigation in civilized countries blest with navigable streams and lakes. This has been very noticeable in Germany for the past ten years. A new law regulating inland navigation in that country went into effect January 1, of this year, by which authority has been granted to the government to regulate the time of loading, of discharging, waiting, etc., and of fixing the charges for the time in certain exceptional harbors. It has, moreover, decreed that ship registers are to be kept.

The British consul-general at Frankfort-on-Main reports that, in the harbors of the Rhine the traffic has risen from 21,300,000 tons, in 1893, to 24,600,000 tons, in 1894,—*i.e.*, by 15 per cent. At the 34 German Rhine harbors, the traffic rose at the same time from 14,600,000 to 16,700,000 tons. The most important Rhine harbors of Germany showed the following traffic in 1894: Ruhrort, 4,693,198 tons; Mannheim (Rhine and Neckar), 3,662,580; Duisburg, 2,579,738; Hochfeld, 958,105; Ludwigshafen, 754,426; Cologne, 637,216; Gustavsburg, 500,283; Dusseldorf, 354,823; Castel with Amöneburg, 317,197; Mayence, 244,641; Neuss, 209,000; Worms, 173,200; Uerdingen, 159,695 tons.

Canal construction has also been active. At the head stands the Midland canal, as in 1886 the Prussian diet sanctioned the Dortmund-Ems canal, but refused in 1894 to have it continued as far as to the Rhine. The Dortmund-Ems canal already is paying attention to larger ships; it possesses a depth of 2.5 meters, and is intended for vessels of 600 or 700 tons, but is so constructed that ships of 800 to 1,000 capacity will gradually be admitted. The Midland canal is to unite the Rhine, Weser, and Elbe with each other, and is to meet the requirements of the present-day shipping. The Midland canal will not only unite the Rhine and the Rhenish-Westphalian mining and industrial center with the Elbe, but also, by means of the Planen canal, unite with the Markish district rivers the center of Berlin, and by these unite with the Oder; and, by means of the network of the Bromberg canal and the Brahe, will connect with the Weichsel. With its completion there will exist a navigable way from the west to the east of Prussia.

Bremen will soon have an efficient water connection with the middle and west of Germany by the canalization of the Weser as far as Merseberg, and a canal joining the latter with the Midland canal. The canalization of the Main from Frankfort to Offenbach is also mooted in South Germany.

Dangers of Coal-Carrying Through Spontaneous Ignition.

THE cause of spontaneous ignition of coal, which is one of the serious risks to vessels in the coal trade, is, according to Professor Medem, in *Kuhlow's Trade Review*, the presence of iron pyrites in the coal. No coal is entirely free from iron sulphid, and, when present in sufficient quantity and under conditions favoring rapid oxidation and retention of heat, iron sulphid generates heat enough to cause the oxidation or combustion of the coal itself.

It would seem that Professor Medem regards as erroneous the common notion that carbon, *per se*, will absorb oxygen rapidly enough to ignite spontaneously. He states that "a pyrophoric tendency is only manifested in charcoal when some of the volatile hydrocarbons have been left behind in the distillation process and enter into combination with absorbed oxygen. If, however, such charcoal be freely exposed to air, the external portions speedily lose this property, owing to the pores becoming saturated with air, but it will regain its pyrophoric character, if powdered so that the internal layers are enabled to absorb oxygen. As the process of chemical combination only goes on in the interior of a heap, the best way to arrest it is to spread the charcoal out, since the attempts at ventilation by blowing or drawing air through the mass will only result in increasing the combustion."

Pyrophoric charcoal regains this quality every time new surfaces are exposed, until it reaches the state of powder; but powdered charcoal, after a sufficient exposure to air, will not again become pyrophoric.

"Hard coals, brown coals, and the like are subject to two dangers, explosion and ignition, each having a separate cause. Explosion is due to the liberation of firedamp following on a decrease in atmospheric pressure, whereas ignition results from the oxidation of the iron pyrites contained in the coal, when exposed to the action of oxygen and moisture. The danger is the greater the finer the state of division of the coal, and coal stacked above ground is particularly liable. Attempts made to reduce the danger by ventilating the stacks have failed in this case also, on account of the increased amount of oxygen thereby introduced into the interior of the mass; and accordingly the coal is stacked as tightly as possible, in order to exclude air. Strangely enough, the practice of ventilating the coal bunkers of ships has not been altogether abandoned, notwithstanding Liebig's impressive warning given as far back as 1866; and neglect in this particular has frequently led to lamentable fatalities. Since 1865 no less than 97 coal-laden vessels have been destroyed and the lives of some two thousand seamen sacrificed through spontaneous ignition of the cargo."

A New Form of Air-Pump.

We have reproduced the accompanying engravings, which will much interest marine engineering constructors, and have condensed the description of the same from *Engineering* (Aug. 14). The pump was invented and designed by Mr. Frederick Edwards of London, and the design presents the following advantages:

No foot or bucket valves to leak and get out of order; the barrel is shorter; the foot valve seat and the flange which supports it are not required; neither is it necessary to have any door in the barrel. The number of valves and working parts are, therefore, reduced to a minimum, and the only valves are in the most accessible position. It is also claimed that two-thirds of the sources of breakdown and delay are

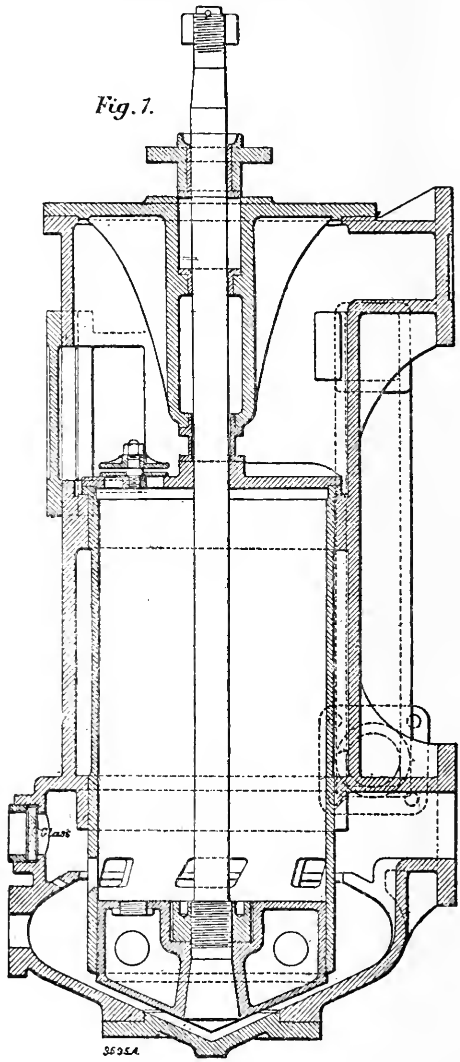
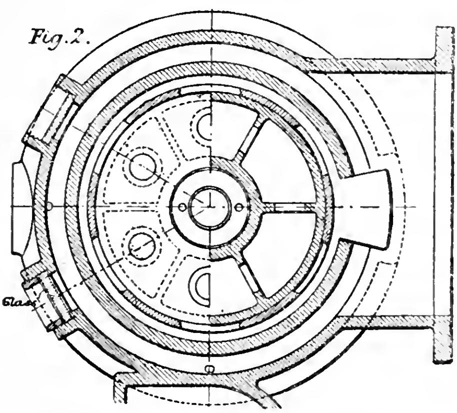


Fig. 1.

removed, and very much less than one-third of the time is required for overhauling the pump. Fig. 1 is a sectional elevation, and Fig. 2 a plan. The bucket is of a coned form underneath, and it nearly fits the bottom of the chamber. When the bucket descends, it strikes the water lying in the bottom, and the water is in this way forced outwards with considerable velocity, striking the curved part of the outer chamber; this changes its direction, and causes it to flow through openings provided in the barrel just above the bucket, the momentum it acquires being sufficient to carry it well up the barrel. The bucket, on its return stroke, closes the ports before the water has time to recover from its upward travel. By this arrangement the necessity for foot and bucket valves is entirely done away with.

The quantity of water an air pump, working in connection with a surface condenser, has to lift is very small, and, in a good triple-expansion engine, generally varies from ¼ in. to ⅜ in. depth on the bucket; in fact, it is ridiculously small compared with the size of the pump.

Fig. 2.



In Mr. Edwards's pump the admission of the air has been made the first consideration and the water a secondary matter, and the latter tends to help the former. When the bucket descends, the pressure above it is that due to the temperature of the water, and, when the ports first open, there is a free entrance for the air, and there is no water passing through the ports, after which the cone of the bucket strikes the water silently without any shock and sends it up into the barrel. The guiding edge and the ports are so arranged that the top of the water is some distance below the top edge of the ports, which leaves a clear entrance for the air, even when the water is going in; and, at the point where the air comes in contact with the water, the latter is travelling at a rapid rate into the barrel, tending to assist the air. In this pump no pressure is required to open any valves or to drive the water up into the barrel.

Salvage Awards.

On June 27 the derelict iron bark, Janet, was towed into the Erie basin, Brooklyn, with a valuable cargo of nitrate of soda. It is said that this will give a salvage of some seventy thousand dollars to the crew of the steamer, Innerly, which saved the vessel. This event gives occasion for the *American Shipbuilder* to make some editorial comments upon the subject of salvage in general. Perhaps no matter of a commercial nature involves the possibility of greater complications than a salvage award. In the United States claims for salvage are adjudicated by the United States district court in admiralty session. In England the admiralty division of the high court of justice decided issues arising from salvage claims. As a measure of economy, both of expense and time, "the leading underwriters of the world," says the *American Shipbuilder*, "have been agitating a plan to do away with the intervention of courts in salvage cases and submit them for settlement exclusively by private arbitration."

Few who have not been at some time interested in the outcome of a salvage claim are aware of the complications which may beset the settlement of such a claim.

"In deciding the amount of compensation each case must rest upon its merits. All the circumstances must be considered. The danger to other property or lives, the skill shown and the danger incurred by the salvors, the losses, if any, of the salvors, the actual or possible losses of the salvors, and the value of the property of both parties, are the chief matters to be borne in mind. The apportionment of salvage is a constant source of disagreement between owners and crews of vessels, especially steamships, which have rendered aid to vessels in distress. Sometimes the work done is so much like ordinary towing, when the crew of the rescuing vessel are not called upon to do any tasks beyond their ordinary work, that the owners feel themselves entitled to all or nearly all of whatever salvage may have been earned. Upon the other hand, masters and seamen frequently form exaggerated ideas of their own merits in a case involving salvage, and expect a lion's share. It is a curious fact that the law does not permit any salvage for saving life. This is because, under the insurance contracts, a vessel is not held to have deviated from her course when she goes out of it to save lives, while, if she goes out of it to save property, her insurance is forfeited, and compensation must be made for its loss. The rule is that salvage services can only be rendered by persons not bound by contract to render them. A crew cannot claim salvage for saving their own ship, not only because it is their duty to save her if possible, but because it would be most unwise to tempt them to let the ship and cargo get into a position of extreme danger that by extraordinary exertion they might secure a claim for salvage. It is the duty of seamen to remain by a wreck so long as it is safe to do so. They have a prior lien to salvors upon everything saved, for their wages. In case of disaster, the master is held to be the agent for the cargo as well as the ship, and is but fulfilling his duty in providing for their safety. Seamen who assist in saving the cargo after a ship is wrecked and the voyage broken up are entitled to extra compensation. If part of a crew leave their ship and go to save another, and thereby acquire a right to salvage, those who remain share in the reward, though not equally, for their rights rest mainly on the increased labor or exposures which fall upon them."

What we have quoted is sufficiently suggestive of difficulty, which, it would seem, a board of sensible arbitrators composed of men familiar with marine affairs could cope with as well as, or even better than, a law court, the difficulty arising mostly from questions of fact, such as juries decide in ordinary civil causes. In this view of the subject, the effort to substitute arbitration for the now usual legal process in courts of admiralty seems commendable.

Detecting the Direction of Sound Signals.

It is often difficult, if not impossible, at sea, to determine whence a sound, as of a fog-horn, bell, gun, or steam-whistle, proceeds. This effect frequently neutralizes to a great extent the usefulness of sound signals as warnings to vessels in positions of danger. A signal that misleads may prove worse than no signal at all. Hence a device described in *La Nature*, and re-described in *Nature* (Aug. 20), is of present interest. We herewith present a brief abstract of this description, which will serve to indicate the nature and use of the device. Two microphones are placed on board at as large a distance apart as possible, say one hundred yards. Each of the microphones is connected with a telephone. The observer holds the forward telephone to his right ear, and the stern telephone to his left. Then, when a signal is given by a vessel straight ahead, he will hear it first in his right ear and then in his left, and the interval will be that required by the sound wave to travel from one microphone to the other.

In the case supposed about one third of a second would elapse between the two hearings,—a more than sufficient interval for distinction between the two auditions.

When the strange vessel is just abeam, the sounds will strike the microphones at the same instant, and the observer will hear them as coincident. When it is just astern, the left ear will be the first to hear the signal. This method, while capable of fixing the angle between the keel of the vessel and the direction of the stranger, does not decide the port-or-starboard question. This might be done by a similar auxiliary apparatus amidships. Another method described by the same author is based upon the interference of sound waves, the sound being received by a tube dividing into two branches, whose ends are placed at a distance apart equal to half the length of the sound wave, and are attached to the ends of a bar capable of rotating in a horizontal plane. When this bar points in the direction whence the wave proceeds, and only then, will the sound heard through the tube vanish by interference. But the wave may be proceeding along the bar either forwards or backwards, so that here again we have an ambiguity. But it must be borne in mind that the choice between two exactly opposite directions is comparatively easy.

Probably the first method would be serviceable in locating the direction of fog-horns, bells, whistles, etc., but the second seems too difficult of exact application to be practicable. We have no doubt that electricity will, in some way, prove the key to the problem of accurately determining the direction of sound waves at sea, as it has in the past been the key to the practical solution of many other physical problems.

An English inventor has succeeded in making field and marine glasses with aluminum tubes so light that, with the aid of a head-band and a peculiar nose-rest that the glasses can be held to the eyes without the use of the hands and with very slight fatigue. This will be a very great improvement, leaving the hands free for making notes, or for signalling, and avoiding the fatigue of the arms in watching the progress of marine races, etc. The nose-rest is padded, and the tubes are maintained steadily in the line of vision. Civil and military engineers will also find this invention serviceable in field-work and reconnaissance.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

7594. The United States First Class Battleship Indiana (Illustrated description). Sci Am–Aug. 15. 1600 w.

7648. Liquid Fuel and Methods of Burning it. Herbert C. Wilson (Abstract of a paper read before the Inst. of Marine Engs., London. General discussion of methods followed by a description of the best means of utilizing the heat of oil fuel for generating steam for machine use). Ry Rev–Aug. 8. 2500 w.

*7656. The Naval Construction Company's Works at Barrow (Illustrated description of a shipbuilding establishment whose annual payment of wages is over $1,600,000). Engng–Aug. 7. Serial. 1st part. 3200 w.

7661. Testing Steel for Marine-Engine Construction (Extract from Foreign Abstracts of Civil Engineers. Methods). Ry Rev–Aug. 15. 1000 w.

*7737. Warping Gear S. S. Algoa (Illustrated description). Eng, Lond–Aug. 14. 400 w.

*7738. The S. S. Jaltra (Illustrated detailed description). Eng, Lond–Aug. 14. 1200 w.

7752. Accident to Dry Dock No. 2—New York Navy Yard (Illustrated description). Sci Am–Aug. 22. 500 w.

7754. The First Class Battleship Indiana (Illustrated description). Sci Am–Aug. 22. 1800 w.

7822. Types of United States War Ships (Brief description of types, from which specific service designed can generally be inferred). Ir Age–Aug. 27. 1300 w.

7839. Are Our Warships to be Run Without Engineers? J. M. C. (Extracts from a communication to the Philadelphia *Public Ledger*, Aug. 14. which show that the costly and extensive machinery of the U. S. Navy, is in danger of neglect from the want of an adequate engineering force to care for it). Am Mach–Aug. 27. 1800 w.

7878.—$1.25. Contract Trial of the United States Coast-Line Battle Ship Oregon. Leo D. Morgan (Illustrated description of the ship and an account of the trial, with data). Jour of Am Soc of Nav Engs–Aug. 9000 w.

*7884. The Steam Yacht "Speedy" (Illustrated detailed description). Engng–Aug. 21. 350 w.

7969. Dimensions of Small Marine Engines and Boilers. J. G. A. Meyer (Directions for designing, which, it is claimed will give good results in most cases, and possibly, not bad results under any circumstances). Am Mach–Sept. 3. 1300 w.

*7998. The Cable Ship "Tutanekai" (Illustrated detailed description of a vessel designed for use in repairing the New Zealand government cables). Elec Rev, Lond–Aug. 21. 800 w.

8040. A Monolithic Beacon Tower, France (Illustrated description of a new light-house at Irvis-Pierres, at the entrance to the harbor of Lorient, France). Eng News–Sept. 3. 1100 w.

*8073. The Waste of Shipping (Data of losses of vessels at sea). Engng–Aug. 28. 600 w.

*8074. The Nippon Yusen Kwaisha (Status of the chief Japanese shipping company. The probable extension of its business). Engng–Aug. 28. 2200 w.

8110 The Bazin Roller Ship (Illustrated description of unique craft launched Aug. 19, from the Cail dock-yards on the Seine). Sci Am–Sept. 12. 800 w.

8111. The Propulsion of Barges. From *La Nature* (Illustrated description of a new method of propulsion by screws, under peculiar and original conditions). Sci Am–Sept. 12. 900 w.

8113. The Launching of Vessels in France. From *La Vie Scientifique* (Processes and material employed in French practice are illustrated and described). Sci Am Sup–Sept. 12. 700 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

The Horseless Carriage.

SPEAKING editorially of the postponement till next year of the thousand-guinea prize competition proposed by *The Engineer* (London), the *Journal of Gas Lighting* says the reasons for the postponement "are very much on the lines of the historic excuses of a local authority for neglecting to ring the town bells in honor of a visiting monarch. As a matter of fact, a satisfactory mechanical road carriage has not yet been produced; and there is very little encouragement for the hope that anything of the kind will be forthcoming either this year or next.

"There are, of course, petroleum road cars and benzoline bicycles, of sorts; but nothing of the kind *in esse* or *in posse* is more likely to supersede the common omnibus, to say nothing of the victoria or the hansom cab, than is Maxim's flying-machine. The condition of the case of mechanical traction as applied to tramway working is quite sufficient warranty for this conclusion. There is no reason whatever why an engine that is competent to drive a road carriage should not in the first place serve a period of probation on the rails; and where is anything of the kind to be seen besides the lumbering steam tramcar, and, very recently, the gas-power car?"

The compressed-air motor now appears as a possibility of the future, unrecognized by our cotemporary, its trial in New York having given very encouraging results as applied to tramway traffic. But the possibility of its use as a motor for carriages on common roads is so remote, and involves so much progress in the general distribution and supply of compressed air, that he would be a bold prophet who should venture to predict its use for this purpose, even in cities, not to speak of country roads. In fact, the journal quoted is about right in saying that the possibilities for general traffic of anything in the way of horseless carriages yet produced are extremely limited. In France it may seem that there is a notable exception,—the Serpollet carriage; but, though this has done some good work on the excellent French roads, a description of its parts shows that the machine is far too complicated a structure for universal use.

The present status of the horseless carriage is summed up in the concluding paragraph of the editorial under review: "All this is far enough from offering even the germ of a satisfactory mechanical road carriage, such as, to use *The Engineer's* sensible test, a busy doctor would like to buy for doing his daily round. It is only when one takes such an example as this, of what is needed in a successful vehicle of the kind, that it is possible to realize how great is the distance that improvement has yet to cover before making such an approach to finality as that attained in the modern bicycle."

Improved Stang Planimeter.

THE planimeter, in this day of indicator diagrams, has become an indispensable instrument to the steam-engine tester. From the complex to the simple it has gone through an evolution, till, in the instrument illustrated and described in *Engineering* (Aug. 14), it appears to have reached an almost final stage of perfection.

"In its simplest form the hatchet, trammel, or keel planimeter consists of a tracing-point and a convex hatchet edge, the point and the edge being connected rigidly together, so that, when the point is moved along any line, the edge describes a curve." It was invented by Capt. H. Prytz, of Aarhus, Denmark.

When in use, the boundary of the figure whose area is to be measured is traced continuously in one direction with the tracer-point, while the hatchet end of the instrument describes a path from which the area can be directly measured.

The author of the article under review, Mr. Ernest Kilburn Scott, was led to design the form illustrated, by the existence of defects in the original form. The improvements are shown in Fig. 1, a side elevation, Fig. 2, an end elevation, and Fig. 3, a plan. The usual hatchet edge of the ordinary form is replaced by a hard steel knife-edged wheel, A ; this is done because, if the hatchet is very sharp, it is

To avoid the inclination of the instrument to one side, which may easily occur with the common form, a flat plate, C, of celluloid, with a small hole, D, at its center, is used as the tracing-point. The plate is kept pressed flat against the paper by the operator, who places his forefinger lightly on the extension, B, and is thus enabled to keep the rest of the hand out of the way. The instrument being thus

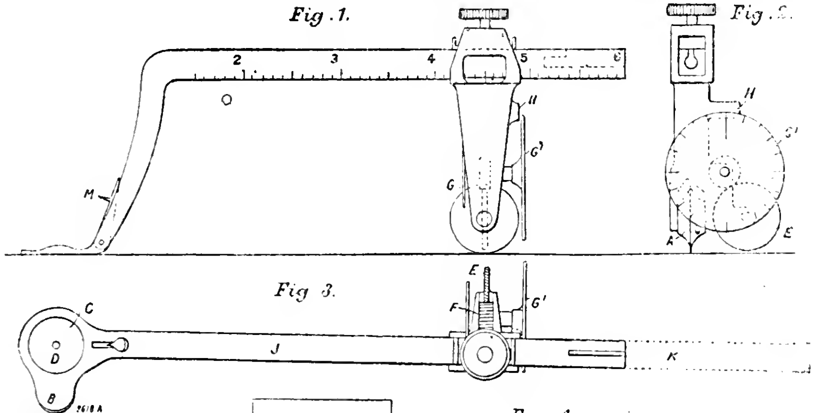


Fig. 1. *Fig. 2.* *Fig. 3.*

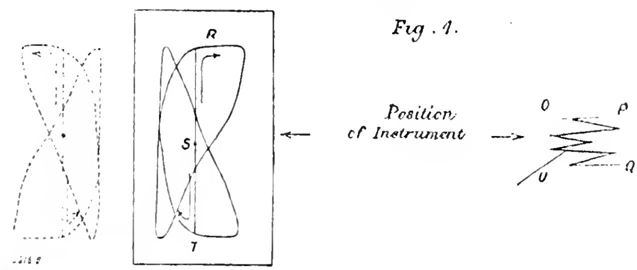


Fig. 4.

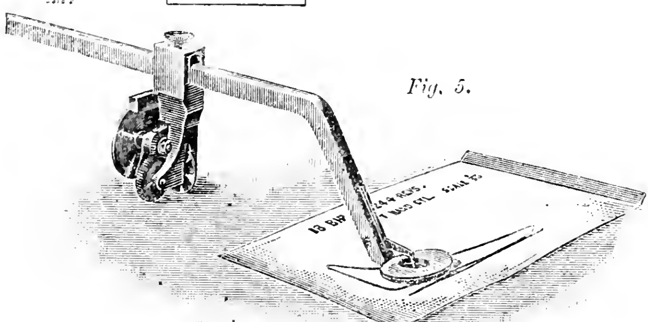


Fig. 5.

liable to cut the paper, or stick ; and, on the other hand, if it is blunt, it does not give a clear dent, and is liable to slide-slip. The wheel may have an exceedingly sharp edge, and, as it revolves with very little friction, the operator is not so liable to jerk the instrument.

maintained in vertical position, the boundary line can be very accurately followed, and very accurate readings secured. The method of using the instrument preferred by Mr. Scott is as follows :

Suppose the diagram to be measured to be 2¾ inches long. The wheel, A, is moved along the stang, J, to double the length of the diagram, or 5½ inches. The diagram is placed on a piece of foolscap paper, and a line, R S T, is drawn from the boundary to the center of gravity, as near as can be judged by the eye (see Fig. 4). The instrument is placed at about a right angle with TR, with the tracing-point in the celluloid plate directly over the point, S. The sliding head is then lightly pressed by the left forefinger, in order to make a slight dent in the paper at P. The tracing-point is then carried along the line, S R, and around the boundary of the figure in the usual way, as indicated by the arrow (being the same direction as that in which the diagram is drawn by the indicator pencil), to S, the point of beginning. Then continue along the line to T, and go around the companion diagram till S is again reached, when another dent, Q, is made in the paper. If the center of gravity has been correctly taken, the distance, P Q, measured on the arc is the mean height of the diagram. In order to get rid of any error due to not having taken the center of gravity correctly, hold the instrument in position, and, after pressing the point, M, down through the hole, D (see Figs. 1 and 3), and the paper beneath, reverse the diagram as shown by the dotted lines. If now the tracing-point is caused to traverse the boundary in the direction of the dotted arrow, the final dent may be, say, at O; then the correct point will be midway between O and P. The furrow made by the knife edge wheel is of course imperceptible to the eye, but it is approximately of the shape shown at U.

To take the distance between the dents measured on the arc is not easy with an ordinary rule, such as must be used with the old form of hatchet planimeter; nor can the readings be made very accurately. In this improved planimeter this difficulty is surmounted by means of the small toothed wheels, E and F, and the recording disks, G and G′ (Figs. 1, 2, and 3). The wheel, E, stands just clear of the paper while the tracing above described is performed and till the two dents in the paper have been made. Then the instrument is slightly tilted to bring the wheel, E, into contact with the paper, and, the knife-edge being then moved from one dent to the other, the wheel work is revolved, and the exact distance is read off at the zero point, H.

By means of lengthening bars, K, the instrument can be adapted to use for large areas, such as maps, and for surveyor's use. To find the area after once circumscribing the figure in the same direction, multiply the distance between the two dents by the distance at which the loose head is fixed on the stang, J; or, if the figure be twice circumscribed, by only half that distance.

The instrument is entirely self-contained, and it gives a direct reading on the recording disk.

It will stand rough usage, and may be conveniently carried in the pocket. By means of the lengthening bars the instrument will measure at a single reading any area likely to be required in every-day work. It is simple and not liable to get out of order, and is as accurate as the Amsler planimeter.

Captain H. Prytz has established the following equation.

$$A = T \times p \times \left\{ 1 - \left(\frac{R^2}{4p^2} \right) \right\}$$

Where

A = the area of the figure in square inches.

T = the distance between the dents in inches, or, where two readings are taken, it is the mean of the distances O Q and P Q. (See Fig. 4.)

p = the length in inches from the movable head to the tracing-point, as indicated on the graduated stang.

R^2 = the mean square of the radii of the figure.

The correction is, therefore,

$$\frac{R^2}{4p^2} \cdot A.$$

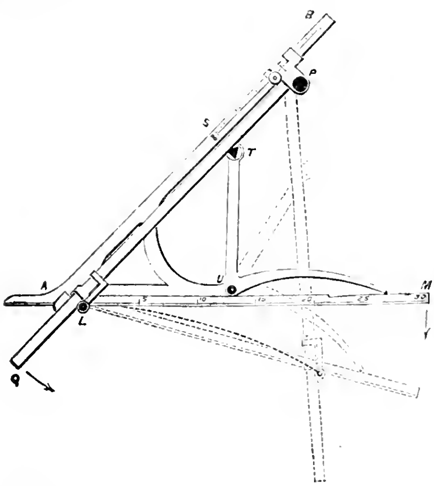
It is found that, for indicator diagrams, the quantity in the brackets is negligible. It is only in cases where the area is large when compared to the length of the instrument that this quantity affects the result. By the lengthening bars, it is easy to keep the length of the stang not less than twice the longest dimension of the area.

Very irregular figures would be best treated by being divided up and each part encircled separately, in accordance with the general practice in such cases. When, for example, the greatest extension of figure is half the length of the planimeter, then, R being less than $\frac{1}{4}p$, the correction $\frac{R^2}{4p^2}$. A is less than $\frac{1}{64}$ A.

The error may, however, be made still smaller by making the length of the stang three times the longest dimension of the figure, in which case it sinks altogether below the bounds of engineering calculations, and one takes the actual reading as with Amsler's planimeter.

The Monticolo Curve-Tracer.

THIS new instrument, designed to supersede the use of sweeps and scrolls heretofore used for drawing curves, is applicable to drawing circles or arcs of circles of larger radius than can be conveniently drawn with compasses or trammel; and it has the advantage, in the latter operation, that the center of the circle to be drawn



need not be located.

From *The Engineer* (Aug. 7) we have condensed the following description, reproducing the cut on a smaller scale. As usually made, the instrument commences with a radius of—11.8 in.; but the radius can be extended to any length in a straight line; that is, arcs of circles having radii ranging from 11.8 in. to infinity may be drawn. The instrument can be made to begin with a less radius, but smaller arcs would be generally described with compasses or trammel.

"In order to describe a curve with the instrument, the index of the slider, P, is placed opposite the point on the graduated scale, R S, which indicates the desired radius, S being the infinity end of the scale. The instrument is then arranged, as shown by the full lines in the figure, the moving arm, P Q, being parallel with and close up to the fixed arm, A R. The pencil or pen for tracing the curve is fixed in the holder, L and is placed at the zero point of the scale on the arm, A M. The pencil or penholder is kept in close contact with the edge of the arm, A M, and, as it is moved to the right, it traces the curve shown by the thick dot and dash line in the figure. It will be noted that this curve has a chord as long as A M, —*viz.*, 30 centimeters, or 11.8 in.

"If it is desired to prolong the curve, draw a line along the right-hand edge of the bar, U T, and erect a perpendicular to it, which shall also be a tangent to the curve already drawn. Now, move the instrument until the zero point on A M coincides with the point where the tangent touches the curve, place A M in line with this tangent, and proceed to trace the curve as before.

"Of course the user may vary the radius of the second curve, if he so desires, and in this way also the different radii of any curving line may be read off, and an exact duplicate of the curve again laid down on another piece of paper, from these readings.

"The instrument is unique in that the curves drawn by it are rigorously arcs of circles, as may be shown by geometrical proof. There is, of course, the personal error of manipulation common to all mathematical apparatus; but, as the instrument is so very simple in construction, this is reduced to its lowest point."

Damascus Gun-Barrels.

THE making of barrels for sporting guns in the valley of the Vesdre, in the province of Liege, France, is a very interesting mechanical operation. These barrels are called "damascus," because the damascene appearance of the metal resembles that of the celebrated Damascus sword-blades, famous for their fine quality. The damascus gun-barrels herein described are made entirely by hand. The United States consul at Liege has described this manufacture in one of his reports, from which we make the following abstract.

The trade has descended through several generations.

The steel is imported from Westphalia; the iron is manufactured at Couvin; the coal for the numerous forges is obtained from the mines of the highlands of the Herve, situated in the vicinity of this industry, which furnish coal especially fitted for this work. The factories receive their motive power from the river Vesdre. The industry is said to be on the increase. Some years ago forges and workshops were entirely engaged in making iron barrels, and there were but few barrel-makers who produced tubes or barrels known as twist barrels, called by the French *canon tordu*, or *tors*, from *tordre*, to twist or contort. The ingot for the production of the curled damascus, which is the favorite design for fine guns, is composed of about thirty sheets of iron and steel, each having the thickness of four millimeters and a breadth of one hundred and twenty millimeters, which form a square mass about fifty centimeters long, and are enveloped in a box of common thin sheet iron or by small wires at each end. The package thus prepared is put into an oven and welded together at the lowest possible temperature. Too great a heat destroys the metal and yields a burned damascus, showing a small if any design. Each barrel receives one hundred and fifty welding heats while being forged, making three hundred heats for a double barrel. If one of these welding heats is unsuccessful, the barrel may be a failure, either by the alteration of the damascene appearance or by a trace of the smallest imperfection in welding. Swedish iron is not used in forming curled damascus—only refined charcoal iron of Belgium, which gives a greater contrasting hue to the steel, and can be welded at a lower heat. After the ingot is welded, it is rolled into small square rods of seven to nine millimeters, according to the design of the damascus desired.

The rods are then drawn into ribbons by the smiths. The manipulation of these ribbons at high temperature is such that in a length of one meter two hundred twists are shown. Coke iron will not answer for this fine work, for which charcoal iron is used exclusively, though an inferior quality of damascus can be made from coke iron. The twisting increases in pitch toward the thinner part of the barrel, which is first formed by winding the ribbons on a mandrel and welding the coils together at the edges. The barrels are then bored out, straightened, ground to the proper thickness, and polished. The joining of the barrels for double-barreled guns is a process requiring great care, as the value of the gun largely depends upon the accuracy with which this part of the process is executed. Each barrel is proved by a shooting test at the manufactory, before it is placed on sale. It is said that the annual production of these barrels is three hundred thousand, and that they are chiefly exported to England and the United States.

Oil in Boiler Scale.

THE following is an abstract of a note on the presence of oil in boiler scale read before the American Chemical Society by Charles A. Doremus. The facts stated indicate the importance of a more critical examination of the organic matter in analyses of boiler scale than is common, "loss of ignition" being far too general a statement.

The author first describes a sample of water obtained by melting the core of cakes of artificial ice. "The sediment is fine, flocculent, and of red color. When removed from the water and dried, it is pulverulent. There is very slight evidence of oil in the dry mass; the moist sediment does not appear oily. The large proportion of oil extracted by ether shows how inefficient the filters were in purifying the condensed steam. Yet very great pains were taken at the ice plant to secure pure distilled water, and there was no visible oiliness in the water as it flowed to the freezing cans. Here, however, the corrosive action of the distilled water on the galvanized iron produced a mass of iron and zinc hydrates which, in being pushed to the center by the gradual formation of ice, gathered the oil and carried it to the core."

A specimen of water from a steamboat on the Hudson river using a surface condenser contained not only sea salt which had entered through leaks in the condenser, but also oil in a precipitate derived from it, this oil being dissolved out by ether.

In a specimen from a large plant in Chicago, evaporating 2,500 gallons of filtered river water and 25,000 of condensed water every twenty-four hours, and in which lubricating oil (mineral with ten per cent. animal) is freely used, the fine clay in the water, together with some incrusting ingredients, caused the oil to form into balls.

Two light-colored samples consisted of a fibrous incrustation composed of calcium carbonate and sulphate, intermingled with organic matter, partly oil.

"Another incrustation in thin sheets about three-sixteenths inch thick, of light slate color, is made up of alternating layers of deposits of varying hardness. The ingredients are again calcium carbonate and sulphate and clay, while there is much organic matter. This can be separated from the mineral in great part by a little acid. The presence of oil is then noticeable. The boiler of this plant is fed with Lake Michigan water and condenser water. The latter goes directly to the hot well of twenty-barrel capacity. While there are no oil filters, the boiler is provided with a skimmer, which draws off floating materials from just below the water line. The lubricating oil used is mineral with fifty per cent. animal.

"Notwithstanding the skimmer, the scale has formed and baked into a hard mass. It is highly non-conducting. It can be held by the fingers quite near to where a portion is heated in a Bunsen flame, the heat of which distils out and ignites the oil. A few pieces of this scale heated in an improvised retort made from a test-tube yield quite a gas flame. The presence of oil to the extent of from twenty to fifty per cent. in the deposits and scale of marine boilers filled with fresh water, any loss being made up from the exhaust or from sea-water, has been fully set forth by Lewes, who also gives the causes thereof and remedies therefor. He also alludes to the possibilities of this type of scale forming in stationary boilers."

The Early History of Rope Driving.

MR. ABRAM COMBE of Belfast, in a paper read before the Institution of Mechanical Engineers, having claimed that Mr. James Combe of Belfast was the first to use rope-driving, *The Electrical Review* (London, Aug. 14), while admitting it to be possible that Mr. Combe believes this assertion, says that, all the same, the allegation does not accord with the facts.

"The mule-spinning frame of Richard Roberts, of Manchester, patented in 1825 and improved in 1830, had the spindles driven by cords, and the rim band is to this day a feature in the spinning mule. Indeed, we believe that a rope was used in the spinning jenny of Hargreaves before Arkwright's time, and Arkwright patented his frame in 1769. We fear that there is no place for Mr. Combe's claim, so far as regards the use of ropes for driving purposes, for their origin dates back probably centuries, and the present writer has seen them on carding engines made before 1850. Mr. Combe, however, applied ropes to much larger powers.

"In 1863 he drove 200 h. p. by means of ropes, and he determined by experiment that the groove angle should be about 45°. The ropes were round, and made of leather, but there was a good deal of trouble experienced with them, and Manilla hemp was tried with better results. Mr. Combe's early proportions of pulley to rope diameter were from 28.8 : 1 to 36.0 : 1 for ropes of 1¼ to 2 inches diameter; and the all-round ratio of 30 : 1 is the modern ratio, and does not differ seriously from Mr. Combe's figures. As regards powers, he fixed on a speed of 100 revolutions as a basis, and allowed 5 i. h. p. for each 1¼-

rope on a 3-foot pulley, 8 i. h. p. for 1½-inch rope on 4-foot pulley, 11 i. h. p. for 1¾-inch rope on 5-foot pulley, and 15 i. h. p. for a 2-inch rope on a 6-foot pulley. These allowances may be increased 20 to 25 per cent. with safety under best conditions with long distance centers, or equally reduced for less favorable conditions.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

7599 Finishing Large Connecting Rods—De La Vergne Shops. John Randol (The description of method is illustrated by half-tone engravings). Am Mach–Aug 13. 2000 w.

7600 The Everlasting Mandrel Question—Expanding Boring Tools. C. O. Griffin (Illustrated description of a system of boring tools and some remarks on mandrels). Am Mach–Aug 13. 1000 w.

7726. Boring 48-Inch Fly-Wheels on a 20-Inch Lathe. C. O. Griffin (Illustrated description of means and method). Am Mach–Aug 20. 500 w.

7838 Laying Out Bicycle Sprockets. A. L. Bowen and F. H. Bullard (An important practical article, illustrated with diagrams, and showing that this mechanism can not be laid out analogously with the teeth of spur-gearing, with good results). Am Mach–Aug 27. 1600 w.

7868. Foundry Cranes. A. E. Outerbridge, Jr. (Read at meeting of Amer. Foundrymen's Assn. A very interesting paper illustrating and describing mechanism for handling heavy materials in foundries from early date to the present time). Foundry–Aug. 3200 w.

7869. Trolley Systems. F. O. Farwell (Illustrated description of a single rail trolley in a foundry with a switch thought to be as safe as any double track switch). Foundry–Aug. 700 w.

7927. Adjustable Bevel for Drawing. F. Spalding (Illustrated description of an instrument for mechanical and topographical drawing, and an explanation of its uses). Mach–Aug. 800 w.

*7944. Turned Foundry Patterns. Herbert Aughtie (Practical hints upon the making of this kind of patterns and the lathe-work involved in them). Prac Eng–Aug 21. 1000 w.

8054. Proportion of Gear Teeth. Samuel Webber (A criticism. The author considers that shearing strength instead of tensile strength should be the basis of formulæ and presents a formula accordingly). Mach, N. Y.–Sept. 1600 w.

8055. Strength of Gear Teeth. Charles L. Griffin (Diagram offered for the convenient use of the method of designing by the use of a factor of strength). Mach, N. Y.–Sept. 1000 w.

8105. Sub-Presses and Compound Dies. A. H. Cleaves (The utility of the sub-press is set forth and illustrated by examples and engravings). Am Mach–Sept. 10. 3300 w.

8106. Gas-Heating Machines (A variety of machines heating with gas fuel articles in process of manufacture, for hardening and tempering and for other purposes). Am Mach–Sept. 10. 1400 w.

Steam Engineering.

*7567. The Economy of the Modern Engine Room. Charles E. Emery (Discussing the problem of boiler selection). Eng Mag–Sept. Serial. 1st part. 5100 w.

†7614. Raworth's "Universal" High Speed Steam Engine (Illustrated detailed description of a design containing many novelties in construction). Ind & East Eng–Aug 1. 1800 w.

7710. The Economical Uses of Coal. John L. Howard (Read at meeting of Pacific Coast Gas Assn. Describes a method of promoting combustion by use of a steam jet of super-heated steam delivered through a peculiar nozzle in the ash-pit door, by which an increase in economy is claimed. Also discussion). Am Gas Lgt Jour–Aug 17. 5500 w.

7746. Value of Circulation in a Boiler. C. A. D. in *The Boiler Maker* (Effects of increase of circulation upon evaporation, increase of economy secured thereby, and different means that have been employed to increase rapidity of circulation). Ir Tr Rev–Aug 13. 2000 w.

7791. Efficiency of the Steam Engine (The author herein enunciates and discourses upon what he considers a rational basis for determination of real efficiency, from which he proceeds to a method for determining practical efficiency). Am Elect'n–Aug. 1400 w.

7799. The Steam Engine Indicator Card (Ideal indicator cards are the only ones considered. Diagrams illustrate the text). Am Elect'n–Aug. 1300 w.

7928. Selecting Boilers for Mills and Factories. W. H. Wakeman (A contribution to practical knowledge designed for the information of manufacturers and steam users). Mach–Aug. 2000 w.

7933. Another Vertical Cotton Mill Engine (Illustrated detailed description of a four-cylinder, triple-expansion engine of 2000 horse-power, to make 232 revolutions per minute). Power–Sept. 1500 w.

7936. Designing a Smoke Stack. A. G. Carlson (Smoke stack for a steam plant of 7680 horse-power. Defects in formulas). Power–Sept. 700 w.

*7942. Seam Rips and Hydraulic Tests (The advisability and value of the hydraulic test of boilers in all cases of inspection is editorially questioned. Especially for the detection of seam rips in egg-ended boilers it is considered worse than useless, though its value for determining tightness in new boilers, or in repairs of new boilers, is admitted). Prac Eng–Aug. 21. 1600 w.

8053. Setting a Slide Valve. F. F. Hemenway (The slide valve has been selected as the most common type, and thus better adapted to an exposition of the principles of valve setting in general). Mach, N. Y.-Sept. Serial. 1st part. 1400 w.

Miscellany.

7593. Trial of the Compressed Air Motor by the Third Avenue Railroad Company, New York (Description of motor, with cuts, and an account of some experiments). Sci Am-Aug. 15. 1000 w.

*7650. The Boydell Traction Engine (Illustrated detailed description). Eng, Lond-Aug. 7. 700 w.

*7658. Smoke Abatement (Editorial review of the report of an English committee for testing smoke-preventing appliances). Engng-Aug. 7. 1500 w.

7727. Flow of Compressed Air in Pipes. William Cox (An adaptation of D'Arcy's formula for flow of water in pipes, to make it applicable to any other fluid, is thought by the writer prreferable for compressed air. The modified formula is presented and discussed). Am Mach-Aug. 20. 800 w.

*7742. The De Dion et Bouton Road Motor (Illustrated description). Engng-Aug. 14. Serial. 1st part. 3000 w.

*7745. An Improved Stang Planimeter. Ernest Kilburn Scott (Illustrated description). Engng-Aug. 14. 900 w.

7757. Cycle Mechanics. H. K. Landis (The statics and dynamics of cycle propulsion, weight, distribution, strength of parts, center of gravity, traction, work done, etc). Sci Am Sup-Aug. 22. 3300 w.

7802. A New Construction for Fly Wheel. A. P. Brayton and Edward S. Cobb (Illustrated description). Min & Sci Pr-Aug. 22. 1000 w.

7821. Standard Specifications for Structural Steel (Specifications adopted Aug. 9, with diagram showing shape and dimensions of standard test piece for sheared plates). Ir Age-Aug. 27. 1600 w.

7832. Machinery Bearings. John Dewrance (Illustrated description of experiments upon the frictional resistance of shafts under loads). Am Mach-Aug. 27. 2400 w.

7833. Flow of Compressed Air in Pipes. F. A. Halsey (A determination of the value of the constant in Cox's fluid flow computer, and a comparison of results with those obtained by D'Arcy's formula, showing that the computer is sufficiently accurate for most practical purposes). Am Mach-Aug. 27. 1000 w.

7834. Metric System (Discussion by members of the Engineers' Club of Philadelphia. A great diversity of views is manifested in the debate, but, on the whole, the weight of opinion seems against the passing of the bill relating to the compulsory adoption of the metric system). Am Mach-Aug. 27. 2500 w.

*7885. The Mechanic's Climacteric (Editorial. Notes the cause why mechanics approaching and passing the age of forty-five years, find increasing difficulty in finding steady employment). Engng-Aug. 21. 2200 w.

*7887. Goodman's Hatchet Planimeters (An improved form by Prof. Goodman of Leeds, Eng., is illustrated and described). Engng-Aug. 21. 2000 w.

7935. Refrigeration for Engineers. Otto Luhr (A plain dissertation upon the philosophy of refrigeration). Power-Sept. 1200 w.

†7967. The Relations of Electricity to Steam and Water-Power. Charles E. Emery (A consideration of cost as dependent upon special local conditions which are stated, illustrated by examples of actual installations). Jour Fr Inst-Sept. 8000 w.

7971. Solid and Hollow Shafts and Their Weight Relation. Henry Hese (Formula for solid shafts and diagrammatic method of finding hollow shafts after the solid shaft has been calculated). Am Mach-Sept. 3. 600 w.

†7990. The Peaucellier Link Work. A. Ewbank (A detailed study of this device for obtaining rectilinear motion from rotary motion). Ind Engng-July 25. 1800 w.

7991. The "Inventive" Faculty. W. H. Smyth (A reply to criticisms upon two articles, to wit, "Is the Inventive Faculty a Myth?" *Engineering Magazine*, Aug., '95, and "Invention the Indefinable Requirement of the Patent Law," *Mining and Scientific Press*, May 4th and 11th, '96. First part replies to a review, in the *Engineering Magazine*, of the second article named). Min & Sci Pr-Aug. 1. 1500 w.

8049. The Watertown Arsenal (Illustrated description, historical and general, of foundry shops, tools, appliances and arms manufactured). Mach, N. Y.-Sept. Serial. 1st part. 2500 w.

8050. A New Power Laboratory. Sidney A. Reeve (Illustrated description of two new laboratory buildings and their outfits, for the department of mechanical engineering of the Worcester Polytechnic Institute). Mach, N. Y. -Sept. 1000 w.

8051. The Wide Belt Heresy. W. L. Cheney (The belief that a wide belt on a wide pulley exerts greater friction than a narrow one, other things being equal, is the "heresy" herein combatted). Mach, N. Y.-Sept. 1000 w.

8052. The Original Corliss Pumping Engine. Lester G. French (Illustrated description). Mach, N. Y.-Sept. 1000 w.

8067. Engineering at Purdue University (Illustrated description). Ry Mas Mech-Sept. 2000 w.

*8101. Thwaites Motor Car Producers (Account of a series of tests with a Thwaites' "simplex" and a "duplex" gas producer. Numerous diagrams and voluminous data). Eng, Lond-Aug. 28. 5500 w.

8108. A Remarkable Clock. W. F. Durfee (Illustrated description of a clock operated by variations in atmospheric pressure). Am Mach-Sept. 10. 2400 w.

8114. Retinning. D. E. Ibbott in *Ironmongery* (Practical suggestions addressed to those who have already a preliminary knowledge of the subject). Ir Age-Sept. 10. 1600 w.

MINING & METALLURGY

The World's Production of Gold.

We hear a good deal, in these days, of the insufficiency of the world's production of gold for supplying an adequate volume of currency. The political orator is fond of representing gold-mining as an insignificant industry, controlled by an aristocratic monopoly, which, in the first place, by means partly occult and partly evident, in "collusion with Lombard street and Wall street," has controlled the legislation of the civilized world, so as to appreciate the value of its hoardings (for, according to these modern new-school economists' value is solely a matter of legislation), and, in the second place, is favored by conditions of supply and demand (so far as these are allowed any force in the new philosophy) in the "fact" that the supply is absurdly insufficient.

Indeed, one might easily conclude that there was no addition being made to the world's supply of gold, but that this was actually decreasing, no doubt being directly consumed by the hated gold-hoarders, who thrive on idle stores locked in their vaults.

It must be most annoying to have the statistician upset this line of fallacy by an abominable array of figures, but the statistician is a pestiferous person not easily silenced. He insists upon promulgating his unanswerable figures, showing that gold production is not only continuing, but vastly increasing, probably at a ratio far greater than proportionate. The situation is thus summed up by *Popular Science:*

"It is now evident that the production of gold for the next fifty years will be altogether unprecedented. This production has been vigorously stimulated by fresh discoveries of mines, by new and cheap mining processes, and by the fall of silver, leading miners to pay greater attention to the other metal. The operation of the latter factor is best seen in Colorado, where the production of gold rose from $5.300,000 in 1892 to $7,527,000 in 1893, and to about $12,000,000 in 1894. The production of 1895 in Colorado is confidently expected to reach $20,000,000. The director of the mint is of the opinion that the production of the United States rose from $33,014,981 in 1892 to about $39,500,000 in 1894, while other good authorities put the production of 1894 at $50,000,000. The annual report of other great producing countries shows a large increase of late years. In his notable article in the *North American Review*, Mr. Preston states that the world's production of gold for 1893 was 'the largest in history, amounting in round numbers to $155,522,000.' The product of 1864, however, very largely exceeded—probably by twenty-five per cent.—the product of 1893. There is scarcely any assignable limit to the gold known to exist in the world, or even in the United States. It is said that simply by the removal of the restrictions on hydraulic mining California can produce half a billion of gold. The quantity easily obtainable in Colorado is stupendous. Other parts of the United States are also rich, while Australia and Russia probably possess a stock equal to our own, and are increasing the annual output every year.

"But the most surprising, and, so to speak, revolutionary facts regarding gold that have recently come to light are those concerning the great Witwatersrandt mines of South Africa. There the gold is found in enormous quantities and in a cheaply workable form in a new geological situation—'in strata the component parts of which are are pieces of quartz held together by a clayey cement.'"

It seems probable, however, that the newer Australian developments may prove even more "surprising and revolutionary," from the point of view of production at least, if not of geologic occurrence.

Two or three propositions are suggested by these premises. One is that the production seems likely to be quite large enough to afford a basis for settling the trade-balances of the world; another is that gold, after all, is like other commodities, and subject to the same influences from increased supply and decreased cost of production; a third is that, measured by the great final standard of labor-cost, gold is not appreciating, but depreciating, in value.

Crystalline Fracture of Iron and Steel.

THE paper by W. F. Durfee on "The Conditions Which Cause Iron and Steel Low in Carbon to be Crystalline," published in the *Journal of the Franklin Institute*, is an important contribution to the literature of a vexed subject, and, although already extensively noticed, will no doubt excite a still wider attention.

By a carefully-prepared table of characteristic chemical compositions, compiled from unquestioned authorities, Mr. Durfee dismisses "the opinion, common among users of wrought iron and soft steel, that the former has no carbon associated with it, and the belief, also prevalent, that the minute percentage of carbon (0.10 to 0.15 of 1 per cent.) in the latter is at once the cause and explanation of the structural dissimilarity of these metals."

He shows "that Lowmoor iron boiler plate has more carbon than extra soft Fagersta steel," Staffordshire boiler plate twice as much, some samples of Russian and Swedish bar iron over four times as much, and a sample of wrought iron made by the Catalan process five times as much.

What, then, is steel as distinguished from iron? Mr. Durfee says:

"To the many answers to this frequently-asked question I will venture to add one more,—*viz.*, steel is iron freed from mechanically-mixed impurities (such as 'cinder,' etc.), by a melting process, during which there is combined with it chemically a small percentage (not large enough to prevent the metal being forged or rolled) of other impurities, introduced for the purpose of modifying its strength, hardness, elasticity, or ductility, in such way and degree as to adapt it to the particular use to which it is to be applied. In short, while wrought iron is iron having (as the unavoidable result of the methods employed in its manufacture) its impurities mechanically mixed therewith, steel is iron having (as the result of the adoption of appropriate manufacturing processes) its impurities chemically combined therewith."

Following out the consideration of the structural peculiarities of wrought iron under this conception, he finds that, "when a properly-heated 'bloom,' or other similarly-constituted mass of wrought iron, is subjected to the action of the hammer or rolls, the contained 'cinder' endeavors to escape from its entangled mechanical alliance with the crystals of the iron, and, in so doing, each particle thereof is driven into some line of least resistance, which is always finally located in a plane at right angles to the direction of the force acting upon the metal. In other words, if the bloom is rolled or forged into a rod or bar, the metal will be acted upon in two directions at right angles to each other, and its compound crystals will be compressed in directions normal to the exterior surfaces of the bar, and at the same time extended in the direction of its length."

"The direct consequence of the elongation of its compound crystals, and the effort of the intervening 'cinder' to escape in the direction of least resistance . . . is the establishment of that structural peculiarity in the resulting bar known as 'fiber.'"

"But let us return to our question. Can a bar of wrought iron of a pronounced fibrous structure be ruptured so as to exhibit a crystalline fracture? I answer, yes—in two ways:

"(1) By a sudden application of a force of extension, commonly called a 'jerk.'

"(2) By a prolonged repetition of a force of compression, sometimes called a 'jar.'"

But this unusual form of fracture Mr. Durfee proceeds to trace to the normal mechanical effect of the treatment upon a compound internal structure, such as he conceives to exist in the iron, and not, as often conjectured, to any molecular or chemical changes in the "crystals" of the iron.

Passing now to steel, he finds that "all steel in our day (save the comparatively unimportant product called blister steel) is made by some process involving melting and casting; and, although the various methods employed all practically free the metal from an admixture of 'cinder,' and in consequence tend, so far as the elimination of cinder is concerned, to produce a homogeneous crystalline structure, still, owing to defects inherent in the method of casting,—and oftentimes in the chemical constitution of the metal itself,—the ingots of steel are too often far from homogeneous. In fact, their structure may be such that, when hammered or rolled, the resulting bar, although destitute of 'cinder,' may, nevertheless, show evidences of 'fiber.'"

This, he thinks, is due to a separation of the crystals one from another, somewhat as in the case of iron, but by a different agency,—*i. e.*, by a multitude of minute cavities. The presence of these cavities, though generally recognized, is usually attributed to some chemical reaction set up in the manufacture or casting of the steel.

Mr. Durfee's "explanation of the formation and distribution of these cavities is a purely mechanical one."

"It is a well-known fact that a vertical stream of any liquid descending freely through the atmosphere drags along with it, by frictional contact, a notable quantity of the air, or of any other gas that may be in its immediate vicinity."

He shows that this tendency increases with the viscosity of the liquid, and would be most marked with such a fluid as molten steel. He discusses very ably the result of the tendency, and the range of effect, under varying treatment, upon the physical properties of the manufactured metal. To the lack of homogeneity thus induced he attributes many of the obscure or unexplained defects observed in steel castings and forgings, but lack of space forbids anything but the indication of his line of treatment. He does not fail, however, to offer, in conclusion, a practical suggestion for improvement.

"After thus discussing the defects of the ordinary method of manufacturing steel, I may be asked how to overcome them.

"I answer, not by removing them, but by preventing the development of their causes,—'blow-holes' and internal ruptures. The first can be prevented by casting the steel in a vacuum,—that is to say, by exhausting the interior of the ingot mold and allowing the stream of molten steel to fall into it, without the possibility of its dragging air along with it. The second can only be avoided by careful heating of ingots which contain no gas-filled blow-holes.

"Eternal vigilance is the price of excellence!"

The Origin of Anthracite.

A HIGHLY interesting contribution to the literature of anthracite is made by Mr. W. S. Gresley, in a paper contributed to the *American Geologist* which has attracted considerable attention and been widely copied, notably by *The Colliery Guardian* (London), which reproduces the article in full.

It is, unfortunately, too long to be presented here, except in brief summary. It is called out by Mr. Gresley's strong dissent from a theory recently advanced by Dr. J. J. Stevenson, who, criticising all leading theories as to the origin of Pennsylvania anthracite and finding them wanting, advances a novel one of his own.

"He considers that the anthracite of Pennsylvania was originally vegetable matter similar to that of which the bituminous seams of the western part of that State are formed, but that the coal is not now bituminous because the accumulation of vegetable matter in the eastern area remained exposed for a longer period to the agencies which formed coal (before being covered up with sediment) than those of the western area."

So that, to quote Mr. Gresley, "the inference is that Stevenson does not consider the partial metamorphism to which the anthracite series of coal measures have, as a whole, unquestionably been subjected has been instrumental in converting the once bituminous coal into semi-anthracites and hard dry anthracites."

Mr. Gresley, on the other hand, as becomes increasingly apparent with the progress of his argument, is inclined to find in metamorphism not only a contributing, but almost the sole, agency in "anthracitification" of the early coal-beds.

To establish the position, he proceeds first to demonstrate the fact of evident metamorphism in the coal measures generally. The evidence, which appears to him satisfactory, is that the fireclays, shales, sandstones, and grits of these regions are more compact, tougher, heavier, and more weather-resisting than those of the bituminous region; that the conglomerates, composed chiefly of quartz pebbles, are extremely compact and dense, and occasionally adjacent pebbles have been partially deformed, or squeezed into one another without fracture, while some quartz veins are noted, running through the conglomerate and passing through the pebbles, which show a fused appearance where incorporated in the veins; that the clay iron stone nodules are very dense and hard, and show distinct zones of mineralization, and contain crystalline pyrite; that the fossils show a peculiar blacklead color and greasy luster observed in those of the States of Rhode Island and Massachusetts and of the Alps; that the coals are very hard, compact, glassy, and remarkable for the quantities of occluded gas existing in them, considering the apparent freedom from interstices or cellular structure; that there is carbon impregnation with streaks of graphite, and a more or less diffused blackening throughout the series; and that "fine crystals of amethystine quartz have been found near Pittston, masses of lead and zinc ores in fissures in the coal-beds near Scranton, smoky and clear quartz crystals near Tamaqua, and very hard and brilliantly crystallized pyrite has been extensively found near Pittston."

Altogether, the anthracite measures "are of greater specific gravity, more crystalline, more siliceous, tougher, harder, and darker than those of the western coalfield of Pennsylvania."

On the other hand, the objections to Dr. Stevenson's explanation are that, "in order to agree with this theory, facts ought to show that the percentage of volatiles in the anthracite decreases with the depth of the seam,—*i. e.*, the lowest bench of coal of any typical seam, other things being equal, ought to be lower in volatile matter and higher in fixed carbon than the uppermost bench; or that there is an apparent gradation in chemical composition from top to bottom of the seam, debituminization having gone on longest and been strongest in the lowest layers. But published analyses do not reveal any such change that may be regarded as of any value in this connection."

Again:

"We may take it for granted that, when a carbonaceous shale enclosing numerous fish remains, shells, etc., forms the uppermost layer of a bed of coal, as is very commonly the case, the inference is that the coal deposit was not suddenly and completely buried beneath sediments on the completion of the vegetable matter accumulation; otherwise no time or conditions would be allowed for the fauna to get there and occupy the waters for long periods, as they evidently did, before the invasions of mud or sand followed. No fish beds have been discovered or reported atop of any of the Pennsylvania anthracite seams. And they seem to be just what Stevenson's theory would call for, if his deferred burial of the coal material actually obtained in that portion of the Pennsylvania coalfield. And, when we get typical bituminous coal capped by fish beds, we almost possess just the conditions of deposition which Stevenson would apply to the anthracite region, but scarcely look for in the non-anthracite areas; so that, if the occurrence of fish beds is any index of delayed oncoming mud or sand deposits, then, on Stevenson's theory, the bituminous coal ought now to be anthracite and the now anthracite bituminous." Mr. Gresley's own theory is that the "anthracite had a metamorphic origin, but is not a product of folding."

"As any stage in debituminization of a coal-bed is to some extent metamorphism, the stage we designate anthracite is a stage in the metamorphic process. Graphite is probably metamorphosed anthracite, just as anthracite is metamorphosed bituminous coal, or bituminous coal is metamorphosed lignite.

"The origin of the anthracite of Pennsylvania was certainly a metamorphic one, and not due or confined only to the certain horizons,—beds of coal,—as Stevenson seems to suggest. The writer does not agree with those who suppose that the metamorphism apparent in the eastern Allegheny coal-fields was principally a result of the folding, crushing, thrust pressures, and of fissuring, which aided the escape of the volatiles of the coal; but he would venture to submit what he will call the hot water or hydrothermal theory, as possibly the most rational one yet advanced, or the one to which all the observed facts or phenomena of the region in Pennsylvania (and certain others beside) fit best."

This theory, as Mr. Gresley develops it, is very briefly, as follows. The existing anthracite measures are remnants of a vast coal-field, and owe their escape from complete destruction by denudation solely to their "synclinal or pockety forms."

The coal-making strata were deposited by and in water, and the fact that the alternating strata are sandstones, grits, and conglomerates rather than slates and shales indicates proximity to a shore line undergoing rapid denudation. The coarser materials would be laid down first, and the finer mud in deeper water.

The rapid deposit of coarse material implies a rapidly-increasing weight of surface strata, which gradually forced the deeper layers, still saturated with water, downward within reach of the influence of the earth's internal heat. At some time—probably in the permian—stratum-building ceased. The action of the interior heat on the water-soaked lower strata caused chemical changes, including "debituminization," accompanied by softening and swelling of the whole layer; softening means weakening, and the swelling forced the weakened strata in the only direction in which they were free to move—that is, upward.

"Accompanying this upswelling of the rocks would be subaërial denudation, and, in conjunction with the assumed lateral thrust given to the mass of rocks by the bordering and perhaps now subsiding land, it seems proper to suppose that severe folding and rapid elevation into mountains would take place. Once the region began to rise, weakness would induce plication; plication and elevation would produce shrinkage, cracking, cooling; and extensive wearing away would accompany these processes. It is highly probable that mountain-forming or the elevating process would go on much faster than removal by denudation or erosion. In the case of the Pennsylvania anthracite region it is supposed that the side pressure on the uprising coal measures, etc., was most severe or operated mainly from the east, thus creating anticlines which have their steeper slopes facing the west, as is found to be the case. The cooling-off of the strata and the deep-seated or elevating pressures combined would produce the jointing, fissuring, and all the observed slip cleavage in the coal, etc. Such, then, is about the best or briefest description the author can give of the successive geologic events to which the anthracite in Pennsylvania is probably mainly due, and upon which we would look back as having brought this splendid fuel within our reach; for, had the coal measures remained down there in plutonic regions, where the anthraciting process went on, the probabilities are man would have been unable to reach it. This coal then, I claim, is essentially a product of the origin, cause, and process of mountain-making,—*i. e.*, internal heat acting upon water-soaked strata of vegetable matter and inorganic sediments, depressed far enough below the surface (prior to a necessary upheaval) to put the rocks through a process of 'cooking;' which process, of course, operated more or less according to depth, kind, and amount of water, the variable character of the individual beds, and local influences."

This "working hypothesis" is fortified by adducing evidences of hydrothermal action in the region—such as hot springs—and of artificial formation of anthracite from wood, by the action of hot water under extreme pressure, as in the timbering of burned and flooded mines.

It is certainly striking; but it seems to dissociate the origin of the mountains of the coal region from the great Appalachian uplift to which they are generally referred, but which, as a whole, could hardly have been caused by the agency suggested by Mr. Gresley.

Discoveries of Mercury in South Africa.

A NEW and apparently important discovery of "cinnabar and mercury bearing alluvial has been made near Johannesburg," says the *Australian Mining Standard*, where "many efforts have been made to discover mercury, previously without success."

The discovery is spoken of as doubtless having great interest for all mine-managers; probably this will be so, although the very extensive use of the cyanid process reported from South Africa must somewhat diminish the importance of mercury.

The deposit reported is remarkable in some respects, and further development will be awaited with interest. The *Standard's* statements as to the richness of the vein of ore are not quite clear, but it appears that concentrates were secured assaying "65.40 per cent." mercury.

So far as yet developed, "the property consists of three hundred claims—about five hundred English acres—with three miles along the formation. It is situated on government ground in the De Kaap goldfields, near the junction of the Umsluimiaiti and Lomatic rivers, and is about twenty miles south of the Pretoria-Delagoa bay railway, to which there is good access. The formation in which the cinnabar occurs is sedimentary, consisting of chloratic and talco-chloratic schists, sandstone, and quartz. On the out-crop the formation has been tilted to almost a vertical position, but in depth they dip to the south. The strike of the formation is east to west, dipping south. The cinnabar occurs particularly on the contact of the talco schists and sandstone mixed with quartz, in veins and veinlets and impregnations. The out-crop now worked extends over 600 yards, and with visible cinnabar; several shafts opened into the out-crop are 10 to 15 feet in depth, a tunnel and cut for formation at 35 feet depth, and 128 feet of driving into the formation. From these several workings about 25 tons of ore have been extracted, of which the samples—several hundred pounds in weight—contain cinnabar with over 10 per cent. of mercury; but many of the samples are much richer. In cutting the alluvial soil for opening the tunnel it has been discovered that such soil is thoroughly impregnated with metallic mercury, and a few openings of this soil gave several ounces of mercury, and, should the same average continue, many thousands of tons of this soil are available. Many very pretty crystals of cinnabar were found. The peculiar nature of the rock admits of a very easy and economical treatment for the reduction of the cinnabar into mercury. The property has easy access to the railway, and a large amount of trees for building, timber, and fuel are on the spot; a large river traverses the property, and will be used for obtaining the motive power."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

7580. Molecular Annealing of Cast Iron (Reviews interesting points in a recent paper by A. E. Outerbridge, and calling attention to the difference of conditions existing in cast iron bars which have been molecularly annealed, when turned or machined for tensile tests, and similar bars tested in "the rough" for transverse strength). Ir Tr Rev–Aug. 6. 1800 w.

*7651. American Plate Trials (Description of the trials, with half-tone illustrations showing condition of the plates and of the projectiles after impact). Eng, Lond–Aug. 7. 1400 w.

*7653. The Walrand-Legenisel Steel-Casting Process. H. L. Hollis (Gives some details of the process, which is practically an addition to the Bessemer process, giving quiet and more fluid steel, and furnishes information regarding physical properties of the metal obtained. From a paper read before the Am. Inst. of Min. Engs). Col Guard–Aug. 7. 1700 w.

7670. Iron Making in Alabama. William B.

Phillips (Extract from the 1896 report of the Alabama Geological Survey. Historical review of the past 25 years). Am Mfr & Ir Wld–Aug. 14. 1800 w.

7671. Blast Furnaces Aug. 1, 1896 (A tabular statement of number, condition, fuel and output). Am Mfr & Ir Wld–Aug. 14.

7673. Treatment of Quicksilver Ores in the Asturias, Spain. From *The Mineral Industry, Vol. IV.* (Describes, with illustrations, the several types of furnaces employed and the method of operating each). Eng & Min Jour–Aug. 15. 3000 w.

*7685. The Iron and Steel Works of the North of Spain (Particulars of the Vizcaya Company's plant at Bilbao). Ir & Coal Trds Rev–Aug. 14. 2200 w.

*7687. A Study of Some Alloys with Iron Carbides; Mainly Manganese and Tungsten. J. S. de Benneville (Paper read before the Iron and Steel Inst. Giving results of experiments upon the structure of iron alloys by a purely analytical method). Ir & Coal Trds Rev–Aug. 14. Serial. 1st part. 4500 w.

7749. Dauber's Gas Blast Furnace (Illustrated description). Am Mfr & Ir Wld–Aug. 21. 350 w.

7774. Treating Tailings by Cyanide (Describes the adaptation of the process to the special difficulties met with in the treatment of tailings). W Min Wld–Aug. 15. 1100 w.

7808. Retort Coking. John S. Kennedy The utilization and the value of the by-products. Different systems of retort coking are also discussed). Tradesman–Aug. 15. 2000 w.

7820. The Wellman Charging Machine (Illustrated description of machine for charging open hearth furnaces). Ir Age–Aug. 27. 900 w.

7827. An Opportunity for An American Steel Rail Plant in Australia (The opportunity here discussed is suggested by the proposals advertised for, by the Secretary of Public Works, at Sidney, for 150,000 tons of steel rails and other track materials). Eng News–Aug. 27. 2000 w.

7893. The Gold-Arsenic Works at Bovisa, Italy. F. Clerici (Describes the ore, plant, and method of treatment). Eng & Min Jour–Aug. 29. 1000 w.

7945. Coal Dust Firing in the Iron Industry. Victor von Neumann (Conclusion of a paper read before the Inst. of Austrian Engs. and Arch'ts. The advantages are said to be a saving in coal, a saving in labor, and absolute freedom from smoke). Am Mfr & Ir Wld–Aug. 28. 1500 w.

†7968. Some Recent Work on Molecular Physics. Reginald A. Fessenden (The behavior of metals which are in every day use, and an attempt to explain this behavior by certain theories, original with the author. Illustrated by numerous diagrams). Jour Fr Inst–Sept. 10000 w.

7984. Modern Methods of Iron Mining and Smelting. William P. Kibbee (Brief account of the chief grades of iron ores, with methods of treatment, etc). Sci Am Sup–Sept. 5. 1500 w.

*7987. Wrought and Cast Ironwork (Historical illustrated description). Ill Car & Build–Aug. 21. 3800 w.

7988. Iron and Steel Works of the United States. From the *Directory of Iron and Steel Works* (Information respecting the development and present number of works and manufacturing plants). Am Arch–Aug. 29. 1200 w.

†7993. An Iodometric Method for the Determination of Phosphorous in Iron. Charlotte Fairbanks (Describes experiments and gives table showing satisfactory results). Am Jour of Sci–Sept. 1500 w.

*8001. The Iron and Steel Industries of Scotland (Illustrated description of the Carron Ironworks, the oldest in Scotland). Ir & Coal Tr Rev–Aug. 21. 3000 w.

*8002. Vanadium Steel. Otto Vogel, in *Stahl und Eisen* (Brief statement of the three methods by which basic steel was treated, in the experiments made M. K. Hélouis). Ir & Coal Trade Rev–Aug. 21. 500 w.

*8003. The Coal and Iron Resources of Spain, with Notices of the Principal Works (The first part consists of historical notes, and account of the coal and iron resources of the north of Spain). Ir & Coal Trade Rev–Aug. 21. 4000 w.

*8008. Note "On the Causes of the Loss of Sulphur in Estimating it by Evolution Methods in Iron and Steel." E. S. Rhead (From the Journal of the West of Scotland Iron and Steel Institute. A corroboration of the results arrived at by Mr. F. C. Phillips). Ind & Ir–Aug. 21. 700 w.

†8021. Aluminum Analysis. James Otis Handy (The method is described with apparatus used, and analysis given. Special methods are also given for determinations other than silicon, copper and iron). Jour Am Chem Soc–Sept. 6000 w.

†8023. The Actual Accuracy of Chemical Analysis. Frederic P. Dewey (The consideration of the subject is confined to analysis of metals,—determinations of manganese in steel, and phosphorous in pig iron. Analyses of copper, gold and silver are also discussed). Jour Am Chem Soc–Sept. 3500 w.

*8091. The Glengarnock Iron and Steel Works (Illustrated description). Ir & Coal Trd Rev–Aug. 28. 3000 w.

*8097. Coke Making (Historical account, with a study of the economical problems connected with the industry). Eng, Lond–Aug. 28. Serial. 1st part. 4500 w.

Mining.

*7566. The Less-Known Gold Fields of Colorado. Ill. Thomas Tonge (A visitor's observations of the resources of the gold belt of Gunnison county). Eng Mag–Sept. 3500 w.

*7639. Transmission of Power in Mines. Rankin Kennedy (The three systems of steam, compressed air, and electricity are compared in this first paper, and special conditions favoring one or another of the systems are pointed out). Elec Rev, Lond–Aug. 7. Serial. 1st part. 2500 w.

*7655. The Coolgardie Gold Fields. Victor Hansard Yockney (The first number is devoted to a general description of the country and the condition of transportation and living). Min Jour–Aug. 8. Serial. 1st part. 2000 w.

7675. Wolfram Ore. R. Helmhacker (Describes the occurrence, mining, and treatment of the ore in the Erzgebirge). Eng & Min Jour–Aug. 15. 1800 w.

7696. Ore Hoisting and Conveying Machinery at Ashtabula, Ohio (Illustrated description). Eng News-Aug. 20. 800 w.

*7730. Copper Ores in the Permian of Texas. E. J. Schmitz (Paper read before the Am. Inst. of Min. Engs. Discusses the occurrence, and refers it to somewhat similar agencies as those producing the Kupferschiefer of Germany). Min Jour–Aug. 15. 2000 w.

*7731. Coaldust : An Addition to the Priority Question. James Ashworth (Coaldûst and explosives and the influence of coaldust upon the safety lamps are discussed). Col Guard–Aug. 14. 1300 w.

*7732. The Problem of Safe Blasting. H. W. Halbaum (Review of the report of the North of England Inst. Flameless Explosives Committee. The report is severely criticised). Col Guard–Aug. 14. 2200 w.

*7733. Firedamp Testing Station at Marchienne-au-Pont. H. Schmerber (Illustrated description). Col Guard–Aug. 14. 900 w.

*7734. Economical Results of Working Thin Seams (From a communication to the Société de l'Industrie Minérale on the working of thin seams in the Franco-Belgian coalfield, by M. F. Cambessédés, professor of Mine Working at the Douai School of Master Miners. Influence of methods of working upon economical results). Col Guard–Aug. 14. 1400 w.

*7739. Wedges and Explosives in Mines (Utility of Elliot's compound wedge). Eng, Lond–Aug. 14 800 w.

*7763. The Leith Mine. H. L. Auchmuty (A description of a modern mine and coke works in the Connellsville region. The geological features of the tract worked, the system of mining employed, and the method of timbering, ventilating and drainage, together with a description of the surface improvements). Col Eng–Aug. Serial. 1st part. 6500 w.

*7764. Robbing Pillars (Correction of popular error as to meaning of expression and very clear explanation of coal mining methods). Col Eng–Aug. 800 w.

*7765. Iron Ore Mining in Michigan (A review of conditions based on report of the Commissioner of mineral statistics). Col Eng–Aug. 1000 w.

*7766. The Twin Shaft Disaster (Description of the mine, its geological features, and the method of mining employed). Col Eng–Aug. 3300 w.

*7767. Plumbing Shafts. George B. Hadesty (A reliable and simple method for carrying a meridian into a mine. Describes a four-wire method, said to be speedy and reliable). Col Eng–Aug. 1500 w.

*7768. Hoisting Machinery. Charles S. Herzig (The methods of hoisting employed at Butte, Mont. An exposition of the inapplicability of the Koepe system to the conditions at Butte). Col Eng–Aug. 2800 w.

*7769. Coal Dust Explosions. John Verner (Argues, as necessary accompaniments of the blown out shot, intense heat and considerable flame, a rapidly moving current of pure air, and coal dust of special fineness and composition floating in the air). Col Eng–Aug. 2800 w.

7778. British Columbia Mines. H. M. Beadle (A general descriptive account). Eng & Min Jour–Aug. 22. 2000 w.

7779. The Gold Industry of British Guiana. David E. Headley (Historical and descriptive sketch). Eng & Min Jour–Aug. 22. 3800 w.

7809. New Soddy Coal Co.'s Coal Washing Plant (Illustrated description). Tradesman–Aug. 15. 700 w.

†7867. On the Occurrence of Galena at Smithfield, N. S. John E. Hardman (Gives what is said to be the first correct account, and suggests the possibility of future development, proving the deposits to be of economic value). Jour of Can Min Inst-Vol I, Pt I. 1800 w.

†7875. Arrangement of Coal Washing Plant for Treating Bituminous Coals. Edgar G. Tuttle (Description, specifications and drawings for a plant capable of handling 300 tons per diem). Sch of Mines Jour–July. 9000 w.

7891. Mining in the Mojave Desert in California F. M. Endlich (Descriptive account of a new gold region). Eng & Min Jour–Aug. 29. 1500 w.

7926. More Gold from South Africa (Indications of new prosperity and expansion in the South African goldfields). Bradstreet's–Aug. 29. 600 w.

*7951. The Leading Gold Mine of Tasmania (A descriptive account of the Tasmania Mine, Beaconsfield). Aust Min Stand–July 23. 4500 w.

*7952. An Auriferous Mountain (Description of an extraordinary discovery in the Gippsland district, near Melbourne). Aust Min Stand–July 23. 1100 w.

*7963. Improvements in Blasting Operations in Collieries. M. C. Ihlseng (A review of the conditions present, and the best practice in view of these conditions). Can Min Rev–Aug. 3300 w.

*7964. Wire Ropes (Practical points for the consideration of engineers and mining students. A collection of papers from the Transactions of the British Society of Mining Students). Can Min Rev–Aug. 3000 w.

7965. State Work in Mining Interests (Favorable comment on the work of geological surveys, and argument for the extension of the interests of mining). Min & Sci Pr–Aug. 29. 900 w.

*8009. Phœnician Mining. A. Cooper Key (From a paper on "Ancient Mining," read before the Inst. of Mining and Metallurgy. The journeyings of the Phœnicians in seeking riches, as few metals were found in their country). Col Guard–Aug. 21. 1800 w.

*8010. Working the Highly-Inclined and Reversed Portions of a Thin Seam at the Escarpelle Colliery. M. F. Cambessédès (From a communication to the Société de l'Industrie Minérale, Saint-Etienne. Details of the method of working). Col Guard–Aug. 21. 1200 w.

*8011. Malay Gold Mining (The extent to which the industry has been carried on under European and Australian auspices). Min Jour–Aug. 22. 900 w.

*8012. The Origin of Placer Gold (What placer gold really is, with a sketch of the more modern views of the mode of the deposits). Min Jour–Aug. 22. Serial. 1st part. 2000 w.

8031. The Great Hoisting Engines for the Anaconda Mining Co. (Illustrated description). Eng News–Sept. 3. 800 w.

8048. The Valuation of Iron Ore. G. Teichgraber (From *Stahl und Eisen*. Showing what determines the cost of pig iron). Am Mfr & Ir Wld–Sept. 4. 800 w.

*8077. Silver Mining in British Columbia. E. D. Ingall (Deals specially with the more newly-discovered silver veins of the West Kootenay district). Min Jour–Aug. 29. 2500 w.

*8078. The Gold Mining Revival in British Columbia (Editorial review of present prospects in this field). Min Jour–Aug. 29. 1700 w.

*8094. The Economical Use of Timber in Mines. H. W. H. (The points of economy in the use of mine timber, with methods considered in their economic bearing). Col Guard–Aug. 28. 4300 w.

*8095. Coal Mining in India (From the report of James Grundy, inspector of mines. Interesting information with description of four of the principal collieries). Col Guard–Aug. 28. 4000 w.

*8096. Further Application of Electric Haulage by Locomotives at the Marles Colliery. M. Baily (Setting forth the improvements in the new installation). Col Guard–Aug. 28. 900 w.

*8098. Interlocking Mine Cages with Anti-overwinding Apparatus (Illustrated description). Eng, Lond–Aug. 28. 2500 w.

Miscellany.

†7579. Note on the Formation of Gold Ore. K. von Kraatz. Translated by H. V. Winchell (Arguments to account for gold in its various forms). Am Geol–Aug. 2500 w.

7606. A Gold-Paved Valley. Dan De Quille (Some thoughts regarding the amount of gold deposited in the valleys of California by the rivers of the Sierras. The indestructibility of gold, and the strange places where it is found). Min & Sci Pr–Aug. 8. 2000 w.

*7625. The Manufacturing Industries of the West of Scotland (A comprehensive review of the iron-ore and coal output, and the pig-iron, malleable iron, and steel manufactures, with other information of a general character). Ir & Coal Trds Rev–Aug. 7. 20000 w.

*7654. The Occurrence of Anthracite. W. S. Gresley (From the *American Geologist*. Criticising Dr. Stevenson's theory of long exposure before covering, and leaning to that of the important influence of partial metamorphism). Col Guard–Aug. 7. 7500 w.

7665. Gas Power Transmission (Editorial review of Mr. Perry's plan for utilization of culm in generating gas for power transmission). Ry Rev–Aug. 15. 1500 w.

7672. Against Petroleum Refineries in Germany (Reviews the opposition of the Brown Coal mining industry). Am Mfr & Ir Wld–Aug. 14. 1000 w.

7674. Diamonds, Where They Occur and How to Search for Them. Melville Attwood (Describes the various types of placer deposits, and the method of examining the gravel). Eng & Min Jour–Aug. 15. 700 w.

*7686. Krupp's Oxidation Experiments with Iron and Steel Plates. H. Otto (Results of twelve years experiments on annealed and unannealed iron and steel of varying composition). Ir & Coal Trds Rev–Aug. 14. 1200 w.

7751. The Petroleum Industry of Sumatra. F. Stampfel (General description of field stated to be very rich in petroleum). Am Mfr & Ir Wld–Aug. 21. 1500 w.

7760. Alabama Furnace Burdens. William B. Phillips (Comments upon the frequent change of burden as an unfavorable feature in Alabama practice). Ir Tr Rev–Aug. 20. 2000 w.

7761. A Coal Handling and Storage Plant (Illustrated descriptive account of the Illinois Steel Co.'s South Works plant, at South Chicago, Ill). Ir Tr Rev–Aug. 20. 500 w.

7826. Basic Steel Rails (Tests of defective basic rails discussed with some notes of European specifications and practice, both as to basic and acid Bessemer rails). Eng News–Aug. 27. 1300 w.

†7874. The Genesis of the Talc Deposits of St. Lawrence County, N. Y. C. H. Smyth, Jr. (The origin is stated to be complex, and to lie in the metamorphism and subsequent exposure to carbonated water, of a bed of impure siliceous and magnesian limestone). Sch of Mines Quar–July. 2500 w.

†7879. The Gold-Fields of Guiana. Thomas Dalgleish (An Arizona miner's adventures in the disputed territory). Century Mag–Sept. 3000 w.

7892. Missouri Granites. Charles R. Keyes (Abstract of article in *Stone*. Describes the occurrence, varieties and characteristics). Eng & Min Jour–Aug. 29. 3300 w.

*7941. The Witwatersrand Chamber of Mines (Some particulars of its constitution with facts from its seventh annual report). Commerce–Aug. 19. 1100 w.

*7961. Quackery in Mining Education (Criticism and reply of Prof. Edgar Kidwell, based upon his contribution to the *Engineering Magazine*). Can Min Rev–Aug. 2000 w.

*7962. The Coal Supply of Canada (A brief summary of hints as to Canada's undeveloped resources). Can Min Rev–Aug. 700 w.

7966. Pine Creek District, Colorado. H. L. McCarn (A descriptive account). Min & Sci Pr–Aug. 29. 2000 w.

MUNICIPAL ENGINEERING

Condensation as Related to the Production of Naphthalene.

THE genesis of naphthalene, that *bête noire* of the gas manufacturer, has of late been made the subject of close study, with a view to its possible prevention. A great variety of suggestions have been made as to its possible cause, and its relation to temperature has been, perhaps, as plausible a suggestion as any. However, experiments with slow, rapid, hot, cold, and fractional condensation have led to no definite conclusion or practice, and, still groping for cause and remedy, the gas-making fraternity appears to be as much puzzled as ever upon the genesis of naphthalene and its effective prevention.

A paper recently read by M. Ymonet before the Société Technique du Gaz—an abstract of which we find in *The Gas World* (Aug. 8)—details an attempt to follow out at Rennes M. Godinet's method practised at Vichy,—to wit, abrupt cooling even to a temperature below that likely to be encountered during distribution.

M. Ymonet said that the apparatus used at Rennes was exactly like that employed by M. Godinet at Vichy, but the results were extremely bad; everything that could choke was choked with thick tar and naphthalene. Three chillings were employed, and to the sudden changes of temperature thus effected the bad results were attributed. Clearly, the conditions in the Vichy experiments must have been quite different from those at Rennes. At any rate the climates are said to be different, and at Vichy the greatest output is in summer, while at Rennes this is not the case. Therefore, at Rennes, after the failure of M. Godinet's method, the principle of progressive cooling by successive steps was tried with entirely satisfactory results.

"When they first appear, the products consist of different materials, each of which has its own boiling-point, and therefore its own temperature of condensation. The whole of the condensing apparatus was put under cover, all at the same exterior temperature; the condensation then took place under continuous cooling, and each constituent found its own condensing-point for itself. Naumann has found that the presence of water vapor facilitates the boiling of hydrocarbons, and lowers their boiling-point. Generally, in a mixture of vapors, when one of these vapors touches its boiling-point, it displaces the boiling-point of the vapors with which it is mixed; or, as M. Brémont stated it to the Société Technique in 1877, in a mixture of several vapors, when one of these vapors attains its condensing point, it displaces the condensing point of the vapors with which it is mixed. But precise data are wanting, and hence uncertainty and controversy. At Rennes there has been no deposit of naphthalene at all, either in the mains or at the works, since the change of method. One thing seems clear,—that the water ought, at latest, to condense at the same time as the tars, and, in any event, before the light tars do. Under the former system, water was found deposited even as far on as the purifiers: now there is practically none, except at first, and what there is has been carried forward as fine rain from the washers. It contains no ammonia, when pure water has been used in the last two columns, and contains exactly the same amount of ammonia as the washing liquor employed, if that be ammoniacal; so that it is simply a question of hygrometric saturation in the washers and of redeposition afterwards. In two works in the same town and using the same coal, ten years ago, the one had its pipes from the retorts exposed to atmospheric fluctuations of temperature, and the gas was suddenly condensed; the other had its pipes wood-jacketed, and the gas came in about 86° F. and was very slowly cooled. The former was often blocked with naphthalene, while naphthalene deposits were unknown in the latter."

From his experiments the author concludes "that the gas leaving the condensers (there being no shock condensation) contains, in the form of very fine fog, a certain quantity of water and light oils holding a small quantity of naphthalene in suspension; that this is not removed by simple condensation, but is filtered off by the purifying material, together with, possibly, a slight excess of naphthalene carried by the gas itself; that the heating of the purifying material causes it to dry up, and the steam produced lifts the naphthalene, which condenses on the purifier lids. But then, while this is an ordinary result, M. Ymonet could get no such deposit of naphthalene at his own works at Rennes, even by chilling the purifier lids; which shows that slow cooling leaves practically no naphthalene in the gas. In hot condensation a large gas chamber is frequently employed; but the stream is not slowed down as is intended; it runs from entrance to exit direct, through an inert mass of gas. This chamber is kept warm, either by injection of steam, which is bad, inasmuch as it leads to great deposits of naphthalene; or by hot jacketing; or by a low-pressure steam worm in the chamber, which is good, for it insures thorough admixture, and prevents the establishment of a direct current from entrance to exit, while the temperatures employed can be regulated with the greatest ease. These temperatures should not exceed from 104° F. to 122° F.; else the water and the heavy tars will not condense out together, as they should, and the result may be the deposition of naphthalene further on."

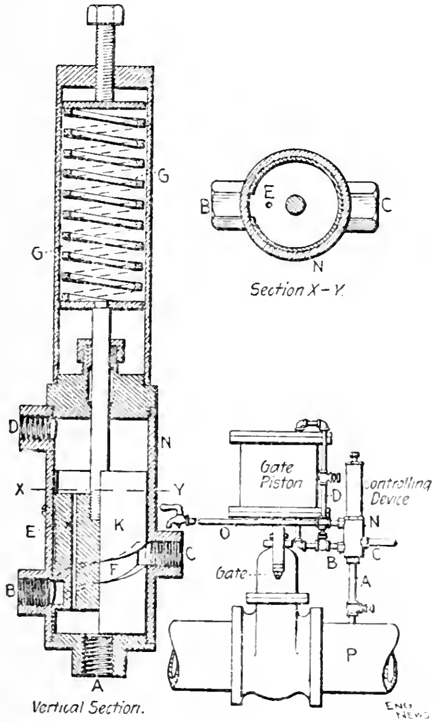
It is claimed that the lighting power of the gas is improved, but the extent of the improvement is not stated.

An Ingenious Gate-Opening Device.

MR. A. L. ADAMS, member of the American Society of Civil Engineers, has communicated to the *Engineering News* a drawing and description of a very ingenious hydraulic device for opening and closing gate-valves at a distance. Omitting his statement of the exigencies at Astoria, Oregon, which directed his mind to the production of this device, we note a prefatory remark that the operating of gates from a distance "is often desirable of accomplishment, especially in connection with the use of stand-pipes and direct pressure for fire protection, and to accomplish the speedy closing of large supply-mains in case of disastrous breaks."

We have reproduced the cut from *Engineering News* to which the description refers, and the description itself, on the principle of pushing along a good thing.

"In the cylinder, N, is a close-fitting piston, K, which moves in opposition to the spring, G. The cylinder, N, has provision for four pipe connections, A, B, C, and D. Connections B and C freely communicate together by way of the inclined port, F, cut around the piston, when the piston is at the lower end of the cylinder. When the piston is raised, the opening, C, is closed, and the opening, B, has free communication with the opening, A. The opening, D, is always unobstructed, whatever the position of the piston. A small hole is drilled through the piston longidinally, as shown at E, which gives free communication between the two ends of the cylinder. This hole is drilled of such size as to have a less delivering capacity under the pressure at which the gate operates than the small pipe extending from the governor to the point from which the gate is to be operated. In operating, A is connected with the pressure pipe in which the gate is placed, a screen being inserted between the main and the governor to prevent the passage of sediment; B is connected with the lower end of the gate cylinder; C with the waste; D with the upper end of the gate cylinder with a tee connection, in one branch of which is connected the line of small service pipe leading to the station from which the gate is to be operated. At the end of this pipe is placed a stop cock or other convenient means of opening and closing the pipe. Under normal conditions this cock is closed, the water has free access from the pipe, P, through A, E, and D to the upper end of the gate cylinder, thus acting on the gate piston and keeping the gate closed. There being an equilibrium of pressure in the two ends of the governor cylinder, the piston remains at the lower end of the cylinder. When it is desirable to open the gate, the pipe at the controlling station is opened, releasing the pressure in D, causing the piston to be thrown to the upper end of the cylinder, which act closes C, and opens B to the passage of the fluid from A, which, acting on the lower end of the gate piston, causes the gate to open while the water from the other end of the gate cylinder passes off through the



Vertical Section. Controlling Device Enlarged General Elevation

pipe, O, at the controlling station. By closing the pipe at the controlling station, equilibrium is again gradually restored in the two ends of the governor cylinder through the opening, E, when the spring, G, throws the piston to the lower end of the cylinder, releasing the water from the lower end of the gate cylinder through the openings and movable port B, C, and F, while the pressure, being again applied to the upper end of the gate piston, causes the gate to close. By reversing the connections between the governor and the gate cylinder, the gate can always be kept open, instead of closed, while the pipe at the controlling station is kept closed."

Mr. Adams states that "the governor has operated perfectly from the very first, and responds instantly to the opening and closing of the cock at the governing station, and the gate operates without production of appreciable ram in the pipes. A check-valve, placed in the supply-pipe from the lower reservoir closes with the back pressure, cutting out a reservoir" (supplying domestic service) "while the fire pressure is on.

The Prepayment Meter System at Lille, France.

THIS system appears to have met with remarkable success in France, in striking contrast with the result in some English towns. Probably local—perhaps national—reasons exist for the difference. Without entering upon this question, *The Gas World* prints an abstract from a paper on prepayment meters read by Melon before the Société Technique, from which we condense the following statements.

The town of Lille, including its suburbs, has a population of about 300,000. About one hundred new prepayment meters are put in every week, the experiment being about eleven months old at the date of the paper. The total number of subscribers at 30th April, 1896, was 14,725, or 1 for every 49 inhabitants, this being greater by 22 per cent. than the corresponding number at 30th April, 1895. During the year the average of new pre-payment consumers has been 296 per month; of ordinary consumers, 19, as against 22 for the whole of the past ten years. The prepayment consumers are, therefore, people who would not have become consumers but for the new facilities: and in number they are equal to the new ordinary consumers brought in during thirteen years with one of the two gas companies in the town, and during seventeen with the other. The classes that have adopted the new system are, in the order of number: (1) wine shopkeepers, etc.; (2) commercial employees, business men, doctors, engineers, and students; (3) foremen and home workmen; (4) bakers, grocers, butchers; (5)

haberdashers, barbers, laundries; (6) functionaries, railwaymen, teachers. The working class—properly so called—has not yet patronized the prepayment meters. There have been put in 3 198 of these meters, 951 of which were put up where the use of gas had been given up, but the fittings left standing; and 55 ordinary meters have been replaced by the prepayment meters. Funnily enough, nineteen of these were for troublesome consumers who would not pay their gas bills promptly, and have been (whether at their own request or not, M. Melon does not say) put on a pay-as-you-go system. Six consumers broke open the meter, extracted the coins, and fled by night; total lost from this cause, 18s. 9d. The total money collected in these meters has been £3,681. The average consumption has been about 840 cubic feet per meter per month. Advertising has cost £252 (this will be no longer necessary), and commissions to collectors £254. The receipts will cover the cost of installation in four years,—that is to say, the slight extra charge made for gas will do so at present rates of consumption.

Excess in Engineering Specialization.

UNDER the title "The Engineering of the City Engineer," *The Engineering Record* (Sept. 5) editorially discusses the increasingly-diversified duties of city engineers, and argues that the specializing of engineering study and practice does not well fit engineers for these varying duties. Nay, it goes further, expressing a fear that specialization has gone too far. How, in the present wide field of engineering, any man can prepare himself to cover all parts of it before reaching an age at which most men begin to think of retiring from active business we are not told. Probably the broader range suggested by our contemporary is not intended to mean such a course of preparation. A narrower field, but yet not so narrow as many engineers now confine themselves to, is probably what is meant; and there is truth in what is said about knowledge outside of one's specialty fitting one all the more for the practice of his particular branch of engineering. Our contemporary says:

"We believe it cannot fairly be denied that the professional man, whether in engineering or anything else, whose educational training and experience have been confined within the narrow limits of a specialty, will be prepared with materially less efficiency to discharge even the duties of that specialty than if his early training and experience had been wider and of a character to afford him a more complete, and therefore truer, view of the things involved in his later practice.

"Again, the broad and general character of civil engineering will inevitably make the civil engineer an executive engineer, so to speak, in many cases requiring both a broad training and a broad prior experience, and the modern city engineer in a large city, discharging the duties demanded in connection with the varied municipal works of the present day, becomes essentially an executive professional man."

The German Gas Industry.

THE number of towns in Germany having gas-works for public supply has increased from 668 in 1885 to 724 in 1896. Concurrently the production at the old works has grown; so that the average yearly increase in the make of gas during that period has been 812,000,000 cubic feet, which is considerably higher than any former rate of increase. Taking the kilo-watt of electric energy as equivalent to thirty-five cubic feet of gas, which is a fairly just assumption when the different methods in which gas is consumed are borne in mind, the maximum productive capacity of the gas-works of German towns is about six times that of the electric lighting stations. The number of electric lamps and the number of gas-burners in use stand in nearly the same proportion. A computation from the increase in the make per hour during the same period shows that the gas production is growing at more than twice the rate at which the supply of electrical energy progresses. Thus far private electrical installations have not been taken into account. As a matter of fact, nearly double the number of lamps served by central stations are attached to small installations; whereas gas is rarely made in private works. The conclusion that must be drawn is that electrical energy is not so well adapted for supply from central stations as from separate installations.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*7564. Gas versus Electricity Direct from Coal. D. M. Dunning (Showing that the invention of Dr. Jacques offers no serious menace to the gas industry). Eng Mag-Sept. 3200 w.

7669. The Columnless Gas-Holder (Editorial disapproving this type of gas-holder and implying that no one of the type has yet met the requirements of a good gas-holder). Pro Age-Aug. 15. 1800 w.

*7678. The Repayment System in Lille (Results attained. An extraordinary success. Data). Jour of Gas Lgt-Aug. 11. 1200 w.

*7708. The Chemistry of Ammoniacal Liquor. W. Ivison Macadam (The obtaining of the maximum quantity of nitrogen from coal in the manufacture of gas). Jour of Gas Lgt-Aug. 18. 1400 w.

*7709. Notes on Gas Burners. A. Gibb (Read at the annual meeting of the North of Ireland Assn. of Gas Managers. Good and bad burners and how the latter may give rise to discontent among consumers). Jour of Gas Lgt-Aug. 18. 1400 w.

7711. The Relative Position of Consolidated Gas and Electric Light Plants. M. C. Osborn (Read at meeting of Pacific Coast Gas Assn. Why gas lost its popularity as an illuminant and the question of economy between running a consolidated plant, or a gas plant and electric lighting plant separately. Also discussion). Am Gas Lgt Jour-Aug. 17. 6000 w.

7750. Daubers Universal Gas Generator (General description). Am Mfr & Ir Wld-Aug. 21. 1000 w.

7783 Oil Tar and Its Uses. J. B. Grimwood (The uses to which oil-tar may be put and the transformation of the raw material into a state of usefulness other than its employment as fuel. Also discussion). Am Gas Lgt Jour-Aug. 24. 4500 w.

7784. Telescoping a Single Lift Gasholder While in Use. L. F. Fogg (Description of the method and appliances used for the purpose stated. Also discussion). Am Gas Lgt Jour-Aug 24. 1400 w.

7785. Gas Stoves. D. Decker (The proper conservation of energy, and the utilization of present waste forces that interfere with the economical distribution of gas). Am Gas Lgt Jour-Aug. 24. 5500 w.

7786. The Evolution of the Gas Meter. C. H. Dickey (A defence of the gas meter as an honest indicator of gas consumption). Am Gas Lgt Jour-Aug. 24. 1500 w.

7899. Water Gas. Charles F. Adams (A recital of interesting experiences with water gas in Portland, Ore). Am Gas Lgt Jour-Aug. 31. 3300 w.

7900. Enrichment of Coal Gas. O. M. Gregory (Read before Pacific Coast Assn. A comparison of results of three months trial with each of three enrichers—namely, shale, gasoline, and petroleum oil. Experiments were made in San José, Cal. Discussion). Am Gas Lgt Jour-Aug 31. 2800 w.

*7901. Difficulties I Have Met With, and How They Have Been Overcome. W. Miller (Experiences of a gas engineer in practice. Discussion). Gas Wld-Aug. 22. 6000 w.

7974. Relation of the Gas Company to the Stove Department. George E. Harris (Inducements for gas companies to put forth special efforts to encourage the use of gas stoves). Pro Age-Sept. 1. 1400 w.

*7976. The Theory of the Pressure-Register as Compared with the Common Gauge or U-Tube. B R. Parkinson (Formulæ and diagrams). Jour of Gas Lgt-Aug. 25. 1500 w.

*8076. The Belfast Gas Works. James Stelfox (Paper read before the Inst. of Mech. Engs. Illustrated description, historical and general). Engng-Aug. 28. 4000 w.

Sewerage.

7584. The Sewerage of Victoria, B. C. E. Mohun (Read before the Canadian Soc. of Civ. Engs. An interesting and instructive general description). Can Eng-Aug. 4400 w.

*7617. Treatment of Refuse in Liverpool (Historical. Covers the last fifty years). Arch, Lond-Aug. 7. 2000 w.

7829. The Sewers and Sewage Farms of Berlin (Review of a report made by the French government engineer, F. Launay, with illustrated description). Eng News-Aug. 27 4400 w.

*7883 Some Recent Experiments in Sewage Treatment at Exeter. Donald Cameron (Abstract of a paper read before the British Inst. of Public Health at Glasgow. The system described is based upon the idea of forwarding to fullest extent the work of natural agents). Engng-Aug. 21. 2500 w.

7982. Visiting the Sewers of Paris. From *Le Genie Civil* (Illustrated description by an eye-witness, with map of itinerary followed in visits to the sewers). Sci Am Sup-Sept. 5. 1100 w.

*8068. Sewage and Sewage Farms. J. H. Garrett (The faults of the system as at present practiced in many places, and their remedies). San Rec-Aug. 28. 2000 w.

Streets and Pavements.

*7571. The Manufacture and Use of Brick for Street Paving. H. K. Landis (Showing the processes of making paving-brick, the qualities desirable in it under different conditions and the methods of testing it). Eng Mag-Sept. 3300 w.

7917. Paving in Toronto (Experience with different kinds of paving and conclusions derived from results). Eng Rec-Aug. 29. 1200 w.

*7938. Street and Road Paving in Germany. Robert Grimshaw (General description). Munic Engng-Sept. 1700 w.

*7939 Some Neglected Points in Municipal Work. H. K. Landis (Defective specifications for street paving are held responsible for faults in work). Munic Engng-Sept. 800 w.

Water Supply.

7583. The Storage of Water in Earthen Reservoirs. Samuel Fortier (A paper read before the Canadian Soc. of Civ. Engs. A very able and elaborate article. The problem discussed is stated and partly handled in the first part, numerous data being presented, and an account of experiments in compacting soils and sub-soils, carried out at the experiment station of Utah is given). Can Eng-Aug. Serial. 1st part 4000 w.

†7608. Is Filtration a Perfect Safeguard? (An editorial negative answer is given to the question propounded. The contingency that at times filters will fail to act, is asserted as ever existing. Examples of imperfect filtration are cited). Ind Eng-July 18. 2000 w.

*7624. The Stockport District Water-Works: Description of Borehole, etc., near Wilmslow. T. Molyneux (Abstract of paper read before the Brit. Assn. of Water-Works Engs. Description of a well 180 feet deep, and nine inches in diameter, from which water is raised 120 feet to the surface by a lift-pump at the rate of more than 750,000 gallons per day. Also discussion). Jour of Gas Lgt-Aug. 4. 2400 w.

*7652. The Use and Misuse of Water. R. E. W. Berrington (A paper read before the Brit. Assn. of Water-Works Engs. Waste of water and its prevention by regulation and restriction in the use of certain plumbing appliances, and the employment of meters, are the topics discussed). Eng, Lond-Aug. 7. 2500 w.

7666. The San Francisco Aerating Plant (Illustrated description). Eng Rec-Aug. 15. 300 w.

*7676. Hydro-Geology and Hygiene: Law and Legislature (Abstract of paper read by C. E. De Rance before the British Assn. of Water-Works Engineers. The relations between hydro-geology and hygiene are set forth and their study is urged as related to sanitary legislation). Jour of Gas Lgt-Aug. 11. 4000 w.

7698. Test of Water-Bearing Gravel at Beaver Falls, Pa. (Illustrated description of an interesting experimental investigation). Eng News-Aug. 20. 2400 w.

7700. A 42-Inch Hydraulic Valve (Illustrated description of a hydraulic piston attachment for opening and closing large gate valves). Eng News-Aug. 20. 400 w.

*7740. New Reservoir, Bury (Illustrated detailed description. Further illustrations to follow). Eng, Lond-Aug. 14. 1000 w.

*7743 The Venturi Water Meter (Illustrated description of a complete meter for a 5-ft. main). Engng-Aug. 14. 500 w.

7825. The Water-Works of Colorado Springs and the Strickler Tunnel (Illustrated detailed description). Eng News-Aug. 27. 5000 w.

7828. A Device for Operating a Gate from a Distance by Hydraulic Power. A L. Adams (Illustrated description). Eng News-Aug. 27. 700 w.

7871.—$1. The New Water-Works of Havana, Cuba. E. Sherman Gould (Illustrated detailed description). Trans Am Soc of Civ Engs-Aug. 5000 w.

*7977. Notes on Sinking, Timbering, and Refilling Concrete, and Puddle Trenches for Reservoir Embankments. W. Watts (Summary of a practical dissertation by an experienced water works engineer). Jour of Gas Lgt-Aug. 25. 2400 w.

*7978. Discharge Tunnels from Reservoirs. James A. Paskin (Read before the Britsh Assn. of Water-works Engineers. Summary of a practical discourse in which the outlets of reservoirs are chiefly considered). Jour of Gas Lgt-Aug. 25. 2800 w.

†7989. Peshawar City Water-Supply Project. Rai Bahadur Gauga Ram (Illustrated description, with editorial. First part gives description of the city and an account of the habits of the people). Ind Engng-July 25. 2700 w.

8015. The Chicago Water-Works Tunnel Extension (Illustrated detailed description). Eng Rec. Sept 5. 1200 w.

8020. Filtration of River Supplies (Illustrated description of water-filtration at Paris). Fire & Water-Sept. 5. 1300 w.

8036. Utilizing Springs as Sources of Water Supplies for Towns. Louis E. Hawes (The origin and causes of springs, their availability for water supply, and examples of their utilization are treated). Eng News-Sept. 3. 4000 w.

Miscellany.

*7565. The Underground Topography of a City. Ill. Wm Barclay Parsons (Showing how sub-surface conditions in cities are studied, and the nature of the facts revealed). Eng Mag-Sept. 4100 w.

7704. The Garbage Crematory at Portland, Ore. A. McL. Hawks (Information collected for Mr. Rudolph Hering and published with his consent. Illustrated description). Eng News-Aug. 20. 800 w.

*7707. The American Case Against Municipalization (Editorial review of the address of Dr. Allen R. Foote against municipalization of gas and electric lighting undertakings, delivered at the Street Lighting Convention at New Haven, Conn). Jour of Gas Lgt-Aug. 18. 1900 w.

7780. Municipal Construction and Ownership of Works for Public Accommodation (Editorial upon the recent decision of the Supreme Court declaring the rapid transit act of New York state constitutional). Eng Rec-Aug. 22. 800 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Cutting of Ties.

THE subject of the cutting of ties under the rail and its bearing upon the design and use of tie-plates continues to attract deserved attention in the engineering press.

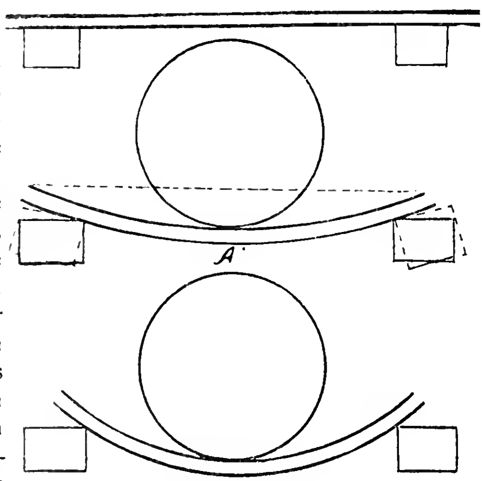
The Railway Review devotes an entire page to the discussion, in the form of a communication from Mr. Jerry Sullivan and a reply by Mr. Benjamin Reece. Mr. Sullivan is skeptical as to the importance of the sawing action to which Mr. Reece is inclined to attribute the entire trouble, and says:

"That it is not the sawing of the rails that causes the rapid destruction of ties may be almost proven by examining a turn-table. The ties near each end will be found cut down considerably, although all the others are in good condition. If the movement of the rail caused the cutting, all ties on the turn-table would receive the same amount of injury; but, because such is not the case, the destruction of the fiber appears to be caused by the compression and hammering of the rail, which reduces it to a dust or pulp, which in turn is blown out as fast as formed by the up-and-down motion of the rail under trains. One cannot readily accept the statement that the very slight daily movement of rails is sufficient to saw ties half in two as rapidly as is done. It appears more probable that the grain of the wood is destroyed by indention of the rail, and that each passing wheel contributes its share toward the general result. Were this not the case; were it true that the creeping of the rail rubbing against the tie caused all the trouble,—why buy costly tie-plates, when a little strip of tin the width of the rail-base, if tacked with a couple of shingle nails across the bearing-surface of the tie, would prevent this rubbing, and save all the trouble with ties and tie-plates?"

Mr. Reece, without noticing the argument, develops his own position so forcibly that we reproduce the diagram and his accompanying exposition.

"A straight line of any length will extend from end to end a further distance than if it is curved or bent, for which reason the chord is necessarily shorter than the arc of the circle which it connects.

"Take, for illustration, a piece of flexible material, and suspend it between two end-supports. If you press down upon the center, you will cause a deflection which draws the ends toward the center, and, if



persisted in, would draw the ends clear from their support, as shown in diagrams.

"As the rail is correspondingly deflected by wheel pressure, the rail is slightly drawn from each end and over the face of the ties toward the point, A, and, when the load is removed, the rail returns to normal position shown by dotted lines, pushing back upon the ties in each direction the same distance it was drawn when deflected under the load. This forward and backward movement occurs more or less under every passing wheel. The observed change of position which we call creeping of the rail is simply the aggregate difference of the total movements of the rail in the one direction or the other, whereas the cutting of the ties is due to the sum total of the movements in both directions."

With all respect to Mr. Reece's pre-eminent qualifications as an authority on the question, it still seems as if Mr. Sullivan appreciated a collateral truth of some importance. It is hard to believe that the cutting is not due in part to the shearing of the wood-fiber by the edge of the rail flange, under a direct downward blow from the wheel; but this cause may be a minor one, and would naturally be more largely operative in such situations as Mr. Sullivan selects for his illustration, where the downward blow is accentuated by the yielding of the structure supporting the track and ties.

The Improvement of Braking Efficiency.

THE *Railway Master Mechanic* has recently published an interesting discussion of the braking power of passenger trains, which it regards as needlessly inefficient, to the great increase of the risks of travel. Indeed, the correspondent who contributes the paper is deeply pessimistic, and adopts as his text the statement that, "at a meeting held some time ago of one of the railway clubs, a superintendent of motive power, whose remarks are always worthy careful consideration, made the following observation, while discussing the design of passenger cars and the general make-up of passenger trains: 'Taking the train as a whole, I believe that we could not get up a better machine for killing people, in case of collision, than the present passenger train.'"

This is, without doubt, a very great over-statement of the case. We could get up a very much better machine, and need go back but a few years in railroad history to find such a machine exemplified in the passenger train of a quarter century ago, which was not only immeasurably behind present standards in braking-efficiency, but added the deadly risks of bad couplings, defective platforms, and weak construction, and piled upon these the horrors of the oil-lamp and the car-stove.

One of the most striking features of the modern accident is the comparative immunity enjoyed by passengers, in the great majority of cases even of serious collision or derailment.

This, however, is far from saying that safety may not be still further and very greatly increased, and the suggestion of the *Railway Master Mechanic's* correspondent may be fruitful of good in this direction. He says:

"Bearing in mind the fact that there are many cars equipped with six-wheel trucks and only four wheels of each truck provided with brakes, which cars are running in trains with cars having all wheels provided with brakes, an average train may be assumed as follows. Two express cars with six-wheel trucks, four wheels of each provided with brakes; weight, 65,000 pounds. One baggage car, four-wheel trucks; weight, 60,000 pounds. Two day cars, four-wheel trucks; weight, 65,000 pounds. One day car, 80,000 pounds, and three sleeping or other heavy cars, 85,000 pounds, each of which has six-wheel trucks, but only four wheels of each provided with brakes. The weight of the locomotive may be distributed as follows: 70,000 pounds on driving-wheels, and these wheels provided with brakes; 30,000 pounds on truck wheels, and these without brakes; 37,000 pounds on two four-wheel trucks, and all wheels equipped with brakes.

"Each weight assumed above is the weight empty. Assuming that the braking pressure on each wheel equipped with brakes is 90 per cent. of the weight on the track under the wheel, then the total braking pressure of the train is about 73 per cent. of the total empty weight. This is the best result that will obtain under the conditions named, and, with the distribution of weight as assumed, is better than could be obtained in practice.

"The other extreme condition will develop from assuming the maximum loading for each car and for the locomotive in working order, and it is found that the total braking pressure is about 60 per cent. of the total weight of the train. Were every wheel provided with a brake, and the braking pressure be 90 per cent. of the pressure under each wheel of the empty car, then the total braking pressure would be about 82 per cent. of the total weight of the loaded train.

"The fact that in many instances the braking pressure is only about 60 per cent. of the weight of the train, whereas it might be about 80 per cent., indicates one way in which the number of accidents might be lessened."

A further risk suggested is that due to the fact that the middle of the train, as ordinarily made up, is braked much more nearly to the maximum than either end. "Stated in tons, the arrangement is as follows: 120 tons in the middle braked to 80 per cent., 200 tons on one end braked to 48 or 50 per cent., and 150 tons on the other end braked to 55 per cent.

"Considering the generally lighter construction of the day cars and their arrangement in the middle of the train, perhaps it should not be surprising if they telescope or 'double up' in a collision."

We believe that derailment of the middle of a train from emergency braking has occurred; but statistics hardly show the danger suggested by the *Master Mechanic's* correspondent to be a very present one.

The Risks of Railroading.

NOT long since, in the department of Mining and Metallurgy in THE ENGINEERING MAGAZINE, we reviewed the surprisingly low ratio of accidents to number of employees engaged in the commonly-esteemed hazardous occupation of mining.

The subject is recalled by *The Colliery Engineer and Metal Miner* in an article entitled "Railroading More Dangerous than Mining," from which we extract the following interesting comparison. The figures, so far as they relate to railroad accidents, are correctly taken from the advance sheet of statistics for the year ending June 30, 1895, issued by the interstate commerce commissioners, and are therefore authoritative.

Out of 785,034 persons employed, "during the year there were 1,811 employees killed, and 25,696 injured. These figures, compared with those of the previous year, show a decrease of 12 in the number killed, and an increase of 2,274 in the number injured.

"One employee was killed for each 433 employed, and one employee was injured for each 31 employed. This ratio is based on the *total* number of employees, including officials, clerks, telegraphers, etc. Of the class known as trainmen,—that is, engineers, firemen, conductors, and others whose service is upon trains,—it appears that one was killed for each 155 in service, and one was injured for each 11 in service.

"This latter class of employees are those that for purpose of comparison should be classed with the mine employees, as, like mine employees, they are the class that take the risk.

"Now, for purposes of comparison, we will take the mine inspector's statistics of Pennsylvania, for the year 1895.

"In the anthracite regions, admittedly the most dangerous mining field, there were 143,610 employees. The fatalities numbered 422, and the number of injured was 1,120. These figures show that there was one killed for each 340 employed, and one injured for each 128 employed.

"In the bituminous fields of Pennsylvania there were 84,904 persons employed, the fatalities numbered 155, and the number of injured was 419. These figures show that in bituminous coal mining there was one fatality for each 548 employees, and one employee injured for each 203 employed.

"Now, it must be remembered that, owing to more extensive mines, greater use of machinery, the presence of more gas, etc., etc., the coal mines of Pennsylvania are the most dangerous on this continent.

"Taking both anthracite and bituminous mining together, we find that there were 228,514 men employed in 1875, and that there were 577 fatalities, and 1,539 men injured. Or, there was one life lost for each 410 employees, and one person injured for each 148 employed. Comparing these ratios with those given for railroading, we find that railroading is almost three times as dangerous as coal mining."

The point in which the excessive risk of railroading appears most striking is the ratio of those injured to those in service. The proportion of one in eleven is appalling, and the mind of the reader reverts at once to the link-and-pin and the defective grab-iron.

It is interesting to note the comparison between English and American figures as to mining fatalities. In 1895, the death rate (from accidents) of underground workers, under the coal mines act, was one per 615 employed, and of similar workers, under the metalliferous mines act, one per 418 employed.

The figures for the English coal mines are much more favorable than for the American bituminous mines, which most nearly compare with them. We would be glad to see the figures of English railroad casualties among employees, and to note whether or not they would show a similar betterment as compared with the record in this country.

The Thousand-Mile Ticket in England.

It is very remarkable, considering the long existence of so many excellent channels for the free interchange of ideas between this country and Great Britain, and the constant flow and reflux of travel between the two countries, that wide differences of practice exist in railroad transportation matters, where, above all, we might presuppose the fullest mutual study of methods and results, and the free adoption by both countries of that which had been successfully tried in either, so long at least as it was not evidently adapted solely to conditions peculiar to the country in which it originated. It is not long, however, since we drew attention to the English railway clearing-house as a highly-developed institution of great value, but comparatively new to American railway men prior to the admirable exposition of its workings made by Dr. William Taussig before the Commercial Club of St. Louis.

In the August issue of The Engineering Magazine we commented upon some points of English practice with regard to special excursion rates, which seemed well suited to adoption here.

Now, as an amusing counter-development, comes the appended extract from the (British) *Railway Times*, bringing out the fact that the thousand-mile ticket, which we would regard as an indispensable part o our passenger-rate system, is almost wholly unknown and apparently very little admired on the other side. This is the way the *Railway Times* regards it:

"The North-Eastern Railway Company seems to have tentatively decided to adopt Artemus Ward's motto: 'You can't go in without paying, but you can pay without going in.' In arranging to issue at reduced rates books of coupons available for twelve months over the whole of the North-eastern system, and for journeys amounting in the aggregate to one thousand miles, the directors are practically saying to the world at large: 'You can't travel without paying your fare, but you can pay your fare without traveling.' If the purchaser of a book of coupons succeeds in using the whole number, he will have secured one thousand miles of first-class railway travel at an average fare of 1¼d. per mile. The idea will doubtless prove attractive to many who, like Mrs. Gilpin, have a frugal mind; but it is never likely to achieve any wide popularity while it remains hedged about with restrictions so numerous and so irritating as those which official ingenuity has devised for the Northeastern 'new departure.' The coupons are not, it seems, to be directly available as tickets; they must be exchanged at the booking-office for the ordinary ticket before the journey begins. Nor will it be sufficient to produce to the booking-clerk the exact number of coupons representing the distance to be traveled. The book itself must be produced for his inspection, and its proud possessor will resemble no one so much as the irascible old lady of the comic papers who carried about a huge family Bible under her arm in order to convince incredulous booking-clerks that her son was under twelve years of age. Probably these regulations are intended to preserve the legend of non-transferability, but the Northeastern, in issuing these coupons, is going so far in the direction of making railway tickets transferable that it is difficult to discern any logical reason for not going the rest of the way."

The restriction, though hardly as troublesome as the *Times* infers, seems needless; but it is a very easy step to the American practice of permitting the surrender of the coupons on the train instead of at the "booking-office."

The *Railway Times*, in conclusion, while admiring the enterprise of the North-eastern Railway Company in initiating the change, "shrewdly doubts whether any large section of the public is anxious to pay five guineas for the privilege of traveling a thousand miles on the North-eastern system. As Punch remarked, *apropos* of the injunction not to marry one's grandmother, 'Who on earth wants to?'"

In America a very great many do desire, not to marry their grandmothers, but to avail themselves of an excellent means of cheapening their frequent, but indefinitely located, journeys over one road or system. Probably the British "commercial traveller," at least, is similarly minded.

The Passing of the British Railway Carriage.

REFERENCE has been made recently in these columns to the possibility at least, if not the probability, of some radical changes in the model of the English railway carriage, which might bring the British passenger rolling-stock of the near future very near to American types of construction, and thus exercise a far-reaching influence, extending, perhaps, to important modifications in standards of track and permanent way generally.

It is significant, in this connection, to note the widespread attention attracted to the new "corridor-trains" which have been recently introduced through the competitive struggle for business between London and Scotland by the east and west coast routes.

Our contemporary, describing the "beautiful new trains," says: "The cars have numerous features that are American. They have corridors the length of the cars, end doors, Gould vestibules, couplers and platforms, Westinghouse brakes, and car-heating apparatus of American manufacture. The cars are each sixty-six feet long." Even ultra-conservative *Engineering* is moved to remark that, "after a very long life, the British railway carriage, with its independent compartments, begins to show signs of having passed its meridian."

So far, it seems to be assumed that, because "this innovation is on a long-distance train, it is probable that, if it finds favor at all, it will be confined to long-distance travel," but it does not need much more than half a prophet to foresee that the innovation will not stop long in any such intermediate stage.

There is, indeed, another consideration which may exercise a powerful influence in bringing about the change, and that is one which is thus introduced in *Transport*:

"The question of outrages in railway carriages is still attracting widespread attention. A lady writes, declaring that it is not only timid and nervous women who feel afraid of railway-traveling under existing conditions. 'I have,' she says, 'traveled for a good many years, and have never experienced the slightest annoyance. But I am none the less aware of the risks which I, in common with every woman, run from the possibility of association with ruffians, criminals, or drunken men. It is not merely the lunatic or the habitual criminal that one has to fear; it is any man whom drink or other exciting cause has for the moment deprived of self-control. Every woman who has traveled at all has painful memories of scares in railway carriages, and, however little these scares may have been justified by actual annoyance, the remembrance is far from pleasant. I recollect setting off once for a holiday with a lady friend from a large terminus. We secured an empty third-class carriage, and, just as the train was starting, two men, evidently tipsy, jumped in. It was too late for us to change, and I shall carry in my mind the image of the lengthening faces of the friends who had come to see us off, as the train steamed slowly out of the station. Fortunately our tipsy companions slept peacefully; but, if they had chosen to make themselves unpleasant, I don't know what we should have done, for they could easily have prevented us from getting to the communicating cord.'"

The writer recounts another instance where relief from a very unpleasant situation on a midnight train was obtained by tipping the guard, but resumes:

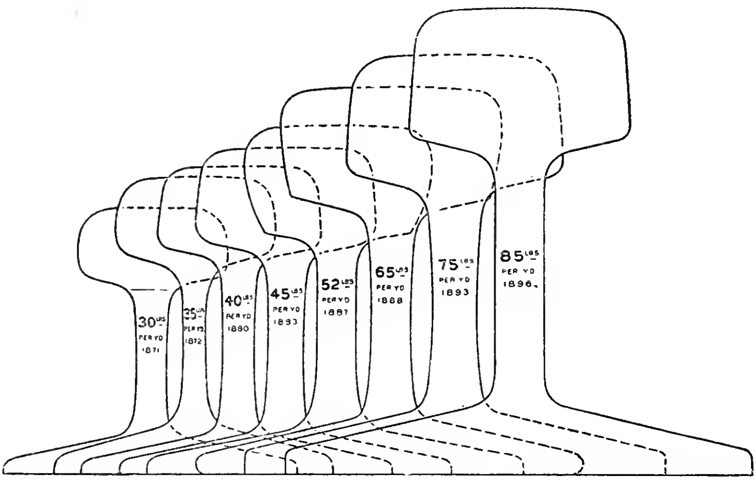
"Suppose, however, that in my place had been a young servant or shop-girl, or even a timid governess, or a girl unused to traveling. She would not venture to call up the guard, and would simply accept whatever accommodation she found. Actresses, musicians, and other women whose professions involve evening engagements are particularly exposed to risk, though, for the matter of that, the worst outrages have, as far as my memory serves me, been committed in daylight. Nor does it matter whether a woman is young or old, plain or pretty, for robbery is a sufficient cause for violence in any case, and sometimes the outrage seems to be motiveless except for the criminal instinct prompting to violence or blackguardism."

Another possibility, even more unpleasant, has recently been noticed in *The Outlook*,—the danger to male travellers from the opportunity given to a miserable class of female blackmailers.

Transport reaches the very inefficient conclusion that "it is quite evident that the railway companies have done as much as can be reasonably expected; and, indeed, it is extremely doubtful if they can greatly improve matters, unless, indeed, they introduce corridor trains throughout their entire systems, and that they can hardly be expected to do, for the expense would be enormous." If the facts are as alleged, the railroads will no doubt have to "greatly improve matters," regardless of the expense; and the demand for increased comfort may be a stronger operative influence than the fear of outrages.

A Quarter-Century of Railroad Growth.

THE annexed cut, showing, by superimposed sections, the rapid increase in size and weight of rails used on the Denver & Rio Grande Railway during the last twenty-five years, epitomizes, perhaps as strikingly as it could well be done, the marvellous growth of the railroad in the last quarter-century.



COMPARATIVE SECTIONS OF RAILS USED ON THE DENVER & RIO GRANDE R. R. FROM 1871 TO 1896.

Engineering News, from which the cut is reproduced, comments upon the various sections as follows:

"There are eight sections, ranging from 30 to 85 pounds per yard, and dating from 1871 to 1896, and these represent three different types of head. The first two (30 and 35 pounds per yard) have heads with round corners and sides, the second approximating somewhat to English sections. The next two (40 and 45 pounds per yard) have heads with outward flaring sides and very round corners. The next two (52 and 65 pounds per yard) have inward flaring heads, which is a distinctly objectionable form of section; and it will be noted that, while the first of these (52 pounds per yard) has rounded sides to the head, the second (65 pounds per yard) has the sides very nearly plane. In the last two rails (75 and 85 pounds per yard) the section approximates to what is now practically the standard type of section, although the top corners of the head are of rather larger radius than is usually considered advisable."

The illustration might be even more striking, though possibly less representative of the general average, if it were taken from one of the largest roads.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

Electric and Street Railways.

*7619. The Brand Electric Railway System (Abstract of paper by Mr. Franklyn read before the Tramways Inst. of Great Britain and Ireland. Illustrated description with sweeping condemnation of the trolley system. The discussion following severely criticises the system described). Elec Eng, Lond–Aug. 7. 4000 w.

7647. Speed, Power and Efficiency of Electric Motors for Locomotives. D. L. Barnes (Abstract of a paper read before the Western Railway Club. Exhibits the extreme simplicity of the principles governing the action of the direct current series motor, and of the relation between speed, power and efficiency). Ry Rev–Aug. 8. 2500 w.

*7692. Meckenbeuren - Tettnang Electric Railway, Würtemberg, Germany (Illustrated description of a small plant possessing features of interest). Elec Rev, Lond–Aug. 14. 800 w.

*7694. Combined Conduit and Trolley Road (Editorial dissertation upon the uselessness of such combinations in most cases, and the difficulties introduced by them). Elec Rev, Lond–Aug. 14. 900 w.

7713. New Underground Electric Railways in London (Present status and projected equipment of all underground London railways with electric motors. Map). Elec Eng–Aug. 19. 500 w.

7756. Gas Motor Tram Cars (Illustrated description of the Luhrig system). Sci Am Sup–Aug. 22. 1200 w.

*7770. Compressed Air for Street Cars (Editorial, reviewing the failures and defects of compressed air, and contrasting it unfavorably with electricity). St Ry Rev–Aug. 15. 1800 w.

*7771. Dead Weight—Is It Profitable or Practicable to Reduce It? (A discussion of the question with strongly affirmative conclusions). St Ry Rev–Aug. 15. 1000 w.

*7772. The Successful Handling of Street Railways with the Dispatcher's Telephonic System. J. L. M'Lean (An exposition of the method, with map of route, forms for reports, etc). St Ry Rev-Aug. 15. 3000 w.

*7773. Niagara Power for the Buffalo Railway (Important details of the project, contracts, and proposed line-construction). St Ry Rev–Aug. 15. 1100 w.

7776. The Walker Company's Series-Parallel Controller System. William Baxter, Jr. (The controller is said to prevent the destructive sparking upon change from series to parallel connection or *vice versa*). Elec Wld–Aug. 15. 2200 w.

7777. The Rochester and Irondequoit Park Railway (Devoted principally to description of power installation of a successful electric road, replacing an unsuccessful steam railway). Elec Wld–Aug. 15. 900 w.

7798. Repair of Street Railway Apparatus (Relates to repairs of the electric motor and its connected mechanism. Instructions for motormen, illustrated by diagrams. The most frequent breakdowns and failures are named). Am Elect'n–Aug. 1500 w.

7806. The Midland Railway of Staten Island (Illustrated description). Elec Wld–Aug. 22. 1300 w.

7812. New York Street Railway Association (Announcement and programme of the September Binghamton meeting). W Elec–Aug. 22. 1000 w.

7817. The Electric Railway Up Mont Saleve, Geneva (Interesting illustrated description of an electric road ascending 4000 ft., with grades of 25%, and curves of 35 meters radius). Elec Eng–Aug. 26. 750 w.

7818. The Brighton-Rottingdean Sea Trolley Road (Illustrated description of a curious and interesting road). Elec Eng–Aug. 26. 350 w.

7837. Electric and Compressed-Air Street Cars. R. D. Williams (A discussion of mechanical efficiency, showing that while this is an important factor, it is not the most important factor in street railway practice). Am Mach–Aug. 27. 500 w.

7851. The Cleveland and Elyria Electric Railway (Illustrated detailed description). Elec Wld–Aug. 29. 600 w.

*7858. Electric Traction in the Isle of Man (General illustrated description of power installation, route, permanent way and equipment). Ry Wld–Aug. 5400 w.

*7859. Tramway Companies' Reports (Compilation of financial and traffic returns of a large number of British roads). Ry Wld-Aug. 1500 w.

*7916. Street Cars Operated by Compressed Air (Statement of the important features of the Hardie system). Loc Eng-Sept. 1300 w.

†7953. The Electric Railway System of the Northern Coast of New Jersey (General Illustrated description). St Ry Jour-Sept. 2300 w.

†7954. The Electric Railway of Rome, Italy (Illustrated description). St Ry Jour-Sept. 1100 w.

†7955. The Street Railway System of Hanover. C. O. Mailloux (Illustrated description). St Ry Jour-Sept. 1100 w.

†7957. Studies in Economic Practice.—Milwaukee. C. B. Fairchild (A review of the Milwaukee system). St Ry Jour-Sept. 3000 w.

†7958. Some Lessons in Car Construction Taught by Old Cars. W. E. Partridge (An illustrated deduction of improved practice from past defects). St Ry Jour-Sept. 1300 w.

†7959. The Growth of Electric Railways in Southern New England (A review with tables and map). St Ry Jour-Sept. 1200 w.

†7960. Running Notches of Series Parallel Controllers Compared. S. L. Foster (A tabulation of data with deduction of results, and comparison of present and possible methods). St Ry Jour-Sept. 2000 w.

7985. The Boston Electric Subway (Illustrated description). Sci Am-Sept. 5. 1300 w.

8037. Paris Tramways, Past and Present (A brief review of their extent and operating policy). Eng News-Sept. 3. 600 w.

8063. The Trolley Conduit Railway in Springfield, Ohio (A descriptive account of the system which is said to give very gratifying results in operation). W Elec-Sept. 5. 800 w.

8065. Chicago's First Street Cars (From the *Chicago Tribune.* Historical review of the introduction of the street railway system in Chicago). W Elec-Sept. 5. 1000 w.

8082. The Akron, Bedford and Cleveland Electric Railway (Illustrated description). Elec Wld-Sept. 5. 1200 w.

8117. Long Distance and Heavy Duty Electric Railways. F. W. Darlington (A paper read before the Pennsylvania Street Railway Assn. A brief review and forecast from both the mechanical and the commercial side). Elec Eng-Sept. 9. 4200 w.

8118. The Hardie Compressed Air Street Car Motors in New York (A review of the system and operation, with conclusions unfavorable to its economy and its mechanical perfection. No actual figures of cost are given). Elec Eng-Sept. 9. 1000 w.

Equipment and Equipment Maintenance.

7627. Reduction of the Weight of Reciprocating Parts in Locomotives (Report of a committee of the Amer. Ry. Mas. Mech's Assn. The importance of the subject is set forth and material and design are considered as applied to the parts under discussion). Eng News-Aug. 13. 3800 w.

7725. The Future of Power Development (A comparison of steam, electricity and gas for locomotive engines). Ry Rev-Aug. 22. 1700 w.

7841. Instruction Car of the Wabash Railroad (Illustrated description). R R Gaz-Aug. 28. 2500 w.

7857. Break-in-Twos (Break-in-twos between cars equipped with M. C. B. type of coupler. To what extent do they occur? What are their causes, and how can they be prevented? Discussion at the Master Car Builders' Assn). R R Car Jour-Aug. 3000 w.

7860. Low Water and Burned Fire Boxes (Oil scale, forming below the water line and causing overheating there, is ascribed as the true cause of many explosions attributed to low water). Ry Mas Mech-Aug. 1100 w.

7861. Malleable Castings as Factors in the Reduction of Operating Expenses (The economy expected is in the reduction of weight and of repairs). Ry Mas Mech-Aug. 800 w.

7863. Traveling Engineers—Their Duties and What They May Accomplish. C. E. Slayton (Abstract of a paper read before the North-West Ry. Club. Gives the organization of their duties C. & N.-W. Ry. and strongly urges the value of their reports to the master mechanic). Ry Mas Mech-Aug. 2200 w.

*7894. Indicator Rigging for Locomotives. A. W. Gibbs (Describes an improvement in the device recommended by Prof. Goss. With full drawings). Am Eng & R R Jour-Sept. 600 w.

*7895. Forty-six-Foot Furniture Car—Chicago, Milwaukee and St. Paul Railway (Description and drawings). Am Eng & R R Jour-Sept. 1000 w.

*7896. Thermal Tests of Car Wheels (Describes tests and suggests the influence of form of wheels upon their behavior under such testing). Am Eng & RR Jour-Sept. 800 w.

*7897. Defects and Improvements in Locomotives (Deals chiefly with economy in fuel consumption). Am Eng & R R Jour-Sept. 1700 w.

*7911. Swindon Works (Illustrated description of the shops of the Great Western Ry., Eng). Loc Engng-Sept. 700 w.

*7912. West Shore Kinks (Illustrated description of shop devices and methods). Loc Engng-Sept. 2000 w.

*7913. Opposing Steel Cars (Cites arguments in favor of wooden cars, based upon German and American practice and experience). Loc Engng-Sept. 1200 w.

7920. Locomotive for Burning Culm—D. L. & W. R. R. (With photograph and full dimensions). Ry Rev-Aug 29. 500 w.

7923. Locomotive Boilers and Tubes (Conclusion of the discussion in the International Ry. Congress). Ry Rev-Aug 29. 1400 w.

*7929. Locomotive Building in Germany (Historical review and summary of important points in modern practice). Eng, Lond-Aug. 21. 2000 w.

*7947. Locomotive Counter-balancing. G. R. Henderson (Deduction and statement of rules with particular reference to the overlooked importance of the proportion of reciprocating weights to balance). Jour Assn of Engng Soc–July. 1300 w.

8043. Car Frames of Wood and Metal. F, E. Stebbins (Diagrams and characteristic points of all principal types). R R Car Jour–Sept. 1500 w.

8044. Compressed Air in Car Painting. W. O. Quest (Illustrations and descriptions of the practice). R R Car Jour–Sept. 1000 w.

8045. Protective Paints for Metal Parts of Cars and Trucks (Symposium of correspondence from M. C. B.'s foremen and paint manufacturers, giving experience and suggestions). R R Car Jour–Sept. 1200 w.

8047. The Railroad Blacksmiths' Convention (Brief report of the proceedings and discussions). Ry Age–Sept. 4, 3000 w.

8066. Reinforcement of Cars on the Northern Pacific Railroad (Details of the methods used for increasing 40,000 lb. capacity cars to 50,000, with diagrams). Ry Mas Mech–Sept. 1200 w.

Maintenance of Way and Structures.

7697. Track Elevation, Chicago & Northwestern Ry., in Chicago (A general review of the character and scope of proposed work, and the methods to be employed). Eng News–Aug. 20. 2200 w.

*7735. Permanent Way of American Railways. E. E. Russell Tratman (An authoritative exposition and defence of American permanent way against British strictures). Eng, Lond–Aug. 14. 2000 w.

7762. Work of Steam Shovels on the Ann Arbor Road (Gives tabular statement of the work of a number of steam shovels, and information regarding the method by which the work was done). Ry Age–Aug. 7. 900 w.

7890. The New England Roadmasters' Convention (Committee reports on spring rail frogs, rail-joints, automatic switch-stands, elevation of curves and minor points). Ry Age–Aug. 28. 2200 w.

7921. The New Passenger Station at Providence—N. Y., N. H. & H. R. R (Illustrated description, with view of completed structure and diagram of station and tracks). Ry Rev–Aug. 29 2300 w.

7922. Rail Cut Ties (Criticism of Mr. Reece's theory, that the cutting is due to longitudinal movement of rail, and Mr. Reece's rejoinder). Ry Rev–Aug. 29. 2200 w.

*7932. Liverpool Street Station Widening (Illustrated description of the extension of Primrose Street bridge). Eng, Lond-Aug. 21. 2200 w.

7950. Track Elevation at South Norwalk (An illustrated description of the permanent and temporary work). R R Gaz-Sept. 4 1500 w.

8033. The Requirements of Tie-Plates for Railway Track. Benjamin Wolhaupter (A discussion of the action and wear of rail and tie under service load, and deduction of principles therefrom). Eng News–Sept. 3. 3800 w.

8038. Rail Sections of the Denver & Rio Grande R. R. (An interesting outline chart of the important sections adopted during the last twenty-five years). Eng News–Sept. 3. 600 w.

Signaling.

7644. Interlocking at Hartford (Description of a 64-lever manual plant at crossing of N. Y., N. H. & H. and N. E. R. R. with plan of switches and signals, dog sheet and locking sheet, and views of machine, lever and connections). R R Gaz–Aug. 14. 400 w.

7716 Signaling and Interlocking on the Union Elevated or Down-Town Loop, Chicago (Description of the installation and operation with plan of the tracks). R R Gaz-Aug. 21. 800 w.

*7915. The Latest Grade Crossing Collision (The Atlantic city collision, used to emphasize the importance of the human element even in the best mechanical systems). Loc Engng–Sept. 800 w.

Transportation.

*7568. Railway Pooling and the Reduction of Freight Rates. H. T. Newcomb (Showing the nature of pooling contracts and how they operate to lower railway charges). Eng Mag–Sept. 3400 w.

7642. New Express Trains in England. W. M. Acworth (Reviews the recent improvements in British passenger service). R R Gaz-Aug. 14. 1000 w.

7643. The Fast Trains Between London and Scotland. J. Pearson Pattinson (Gives in descriptive and tabular form facts regarding typical British express service). R R Gaz-Aug. 14. 350 w.

7646. Thousand Mile Railway Tickets in England (Criticises strongly the value or advantage of the system as recently introduced on the North-Eastern Railway). Ry Rev–Aug. 8. 700 w.

7724. Regulation of Commerce (Abstract of the report of the Kansas Railroad Commission, concerning "reasonable rates"). Ry Rev–Aug. 22. 2500 w.

7835. English Facilities for Handling Freight —Hydraulic Cranes and Capstans (System illustrated by description of a typical freight house on a large English railway). Am Mach–Aug. 27. 1200 w.

7840. A Suggestion for an Improvement in Train Schedules George B. Leighton (A plea for afternoon trains for runs of moderate length). R R Gaz–Aug. 28. 900 w.

7844. The Grain Exporters' Complaint (Rates on grain to New York, are made the basis of a discussion of the merits of this particular case, and of some general comment on rate making and differentials). R R Gaz–Aug. 28, 2800 w

7889 Have Transportation Rates Decreased? (Statistical figures reviewed to show the enormous reduction, in refutation of the political utterances of the free silver candidate). Ry Age–Aug. 28. 1000 w.

7919. Rules Governing the Loading of Lumber and Timber on Open Cars (Abstracted from pamphlet issued by the M. C. B. Assn). Ry Rev–Aug. 29. 2000 w.

7924. The Objection to "Pooling." E. W. J. (A defence of the maxim "combination in rates, competition in facilities"). Bradstreet's–Aug. 29. 1000 w.

8032. Notes on a Transcontinental Trip (The notes are of characteristic features of the train service on the various roads travelled over). Eng News-Sept. 3. Serial. 1st part. 3600 w.

8041. Discrimination Under the Short-Haul Clause (Summary of the Lynchburg case, with Interstate Commerce Commission ruling, denying the right to maintain higher rates for a shorter haul, even when the disproportion is caused by competitive reductions at the farthest point). Bradstreet's-Sept. 5. 900 w.

8046. Can Rate Cutting Be Prevented by Injunction? Opinion of Judge Simonton (The opinion is adverse to the court's power of interference in the case as presented, but implies that the limitations are from the special circumstances and not from general principles of law). Ry Age–Sept. 4. 1900 w.

Miscellany.

*7641. Lightning Express Railway Service (Criticises unfavorably a proposed 150 mile an hour "single rail" system, exhibited in model, on the ground that the weight of passengers has been ignored in calculating C. G. and effects centrifugal force). Elec Rev, Lond–Aug. 7. 1600 w.

7645. The Nippon Railroad of Japan. R. Unno, traffic manager Nippon Railroad, in *N. Y. Railroad Men* (Gives general account of the road and contrasts present and recent conditions in Japan). Ry Rev–Aug. 8. 800 w.

7663. A Railway Engineer (Reviews a criticism of American practice in Indian Engineering, and defends the system of entrusting work to practical mechanics under expert engineering supervision). Ry Rev–Aug. 15. 1400 w.

7664. Relics of the Big Four Railway (Historical notes on some early construction equipment, and the popular conception of railway undertakings sixty years since). Ry Rev–Aug. 15. 1700 w.

7695. An Atlanta View of the Railroad Situation (Review of the political bearings of the railroad situation, especially as regards charter rights). Mfrs Rec–Aug. 21. 1200 w.

7715. Laboratory Tests of Brakeshoes (Reviews past work of M. C. B. committee, describes apparatus and manner of testing, and gives diagram of results). R R Gaz–Aug 21. 2800 w.

7718. Train Accidents in the United States (Classified review of July accidents, with comment). R R Gaz-Aug. 21. 2700 w.

7719. The Heilmann Locomotive (A brief descriptive account of the locomotive and the experimental results attained with it in France. It is to be tried in this country). R R Gaz–Aug. 21. 900 w.

7721. Sand Tower, Chicago & Northwestern Railway (Brief description, with drawings). Ry Rev–Aug. 22. 700 w.

7722. Railway Receiverships and Reorganizations (Abstract of President Moorfield Story's address before the American Bar Assn. Methods at present in vogue. A statute designed to correct some of the evils in this connection was recently enacted in Kentucky and formed the text of the speaker's remarks). Ry Rev–Aug. 22. 1400 w.

*7736. Mechanical Haulage. J. Sturgeon (Read before the Tramway Inst. of Gt. Britain and Ireland. A discussion of traction by adhesion and by haulage, strongly favoring cable as against electric traction). Eng, Lond–Aug. 14. Serial. 1st part. 2700 w.

7755. Rack Railways (A review of some of the principal rack railways of the world, with illustrations of distinctive features of the line and equipment). Sci Am Sup–Aug. 22. 2000 w.

7843. Railroad Statistics of the United States (Abstract of statistics from advance sheets of Poor's Manual for 1896). R R Gaz–Aug. 28. 600 w.

7862. Labor Organization a Detriment to the Railroad Employé. William Gibson (Abstract of address before the Central Assn. of R. R. Officers. Enumerates some of the features of railroad labor organization which appear to be a disadvantage to the employé). Ry Mas Mech–Aug. 2500 w.

*7909. Notes from Argentine Republic. Ai Dolf (The notes of chief importance are upon the use of petroleum fuel). Loc Engng–Sept. 1800 w.

*7910. Accident to the West Coast Racer (Descriptive and illustrated account of the Preston derailment). Loc Engng–Sept. 450 w.

*7914. Investigations of Train Resistances (Reviews discrepancies and opinions, formulæ and test-results). Loc Engng-Sept. 1700 w.

7925. English Railroad Prosperity (A review of the substantial basis for present prosperity of the English railroads). Bradstreet's–Aug. 29. 1100 w.

*7930. The Regent's Canal, City, and Dock Railway (Describes past and present status and prospects of a London partial "belt road"). Eng, Lond–Aug. 21. 800 w.

*7931. With the West Coast "Flyer." Charles Rous-Marten (Detailed descriptive account of a typical run on an English express). Eng, Lond–Aug. 21. 1700 w.

†7956. Organization and Operating Methods of the Metropolitan Street Railway Company of New York (A general review of the operating system illustrated by map and charts). St Ry Jour-Sept. 4500 w.

8013 —$1. The Union Pacific Railway. J. P. Davis (Historical review with discussion of the financial and political aspects of the past, present and future relations of the railroad to the state). An of Am Acad–Sept. 12500 w.

*8042. Light Railways and Motor-Cars. R. H. Rew (A discussion of the importance and relations of light railways to agriculture, with comment on continental experience and practice). Ind & Ir–Aug. 28. Serial. 1st part. 2000 w.

SCIENTIFIC MISCELLANY

Sailing Flight.

THE most expert aeronaut in sailing flight, the late Herr Lilienthal, did not, so far as we are aware, support the theory that soaring birds are able to rise by upward currents of air, availing themselves of these currents at frequent intervals to maintain themselves on the wing for hours without apparent muscular effort. On the other hand, Mr. Maxim and others hold that these currents sufficiently account for the facts of soaring flight, assuming that, where soaring birds remain long in the air, such currents are always present at frequent and short intervals, and that, when birds float through one of them, they receive an upward impulse that sustains them till they pass into another. Mr. Maxim is well enough versed in the laws that govern the circulation of fluids to understand that, in an ocean of either water or air, currents in any direction imply counter-currents of equal energy in an opposite direction. So, alternately passing through upward and downward currents, soaring birds must be assumed to have some means of rendering the upward currents available and avoiding the effects of the downward currents; otherwise the theory fails. This power of adaptation is supposed by some to lie in the wing structure, which engages the upper currents of air more strongly than downward currents.

We have always questioned this explanation of soaring flight. Now, to *Nature* (August 6) a Mr. S. E. Peal of Sibsagar, Asam, has sent a very interesting letter, which confirms preëxisting doubts that the soaring of birds can be satisfactorily explained on the assumptions named. For the existence of alternate upward and downward currents within short distances on all occasions is a pure assumption, and the theory that wing structure accounts for all the difference in the effects of the two kinds of currents is also pure assumption, as yet unsupported by observed facts.

The soaring birds of Asam are the cyrus, the pelican, the vulture, the adjutant, etc., and the weight of the cyrus or of the pelican is frequently twenty pounds. Mr. Peal asserts that, when the northwest wind is blowing, the absence of the alternate upward and downward currents is distinctly proved by the steady horizontal movement of cotton tufts floating in the wind, and that, through a powerful telescope, he has at a long lateral distance watched, for hours, these heavy birds and the cotton tufts without the slightest indication of the assumed currents. The birds, he asserts, rise in a spiral course to the height of from one thousand to three thousand feet. After rising above surface eddies, their wings are rigidly extended, and only slight movements of their tails are now and then perceptible. He says (after an explanation of the position of the wings with reference to the body of the birds, and the position of the primary feathers with reference to the wings): "There is an entire absence of the mental and physical alertness and agility which would be constantly needed if these birds depended on inequalities of wind pressure and equally sudden and invisible up gusts to save themselves from falling." Mr. Peal anticipated in his letter the very accident by which Herr Lilienthal recently lost his life. He says:

"Herr Lilienthal is probably on the right trail. I see he desires to turn and meet the breeze; but in this movement, I fancy, the upper central aeroplane—so high above the center of gravity—will turn him over in a strong wind. In the bird's case (when turning) there is very obviously strong centripetal counter pressure, and great speed, quite sixty miles an hour, I should suppose, at end of the leeward lap. . . . The lifting is mainly done when it turns and meets the wind, and speed is slowed down, and the overturning is prevented, when the wings are laterally presented to the wind, by the great *lateral* expanse. As there is none of this latter, in the centrally superposed plane machine the bird's great lateral steadiness is structurally absent.

"Soaring machines may be of two types: A, those *containing* their own power; and B, those deriving it from the surroundings only. There is no screw in the stern of the 'Bov Tokla,' as he wheels round and round close over me, as I sit hidden in a tuft of grass on the wide plain. Rising to windward, he circles over me at two hundred feet or so, and with binoculars, or even without, I can see each feather, and hear the loud noise they make; there is never a move, except a little in the tail, yet lap by lap the bird steadily rises, and as steadily, if slowly, gets a drift to leeward. I do not suppose the bird can soar without expenditure of energy; all I desire to point out is that upward air currents do not lift and sustain it; also that the lifting is seen to be applied to the primary wing feathers almost entirely, and in a way which shows the lift is due to lateral translation. Tie a primary at the end of a long light stick, and, on whirling it, the effect is obvious."

The Plague of City Noises.

J. H. Girdner, M. D., in *North American Review* for September, discusses a question of great interest to dwellers in cities. The physiological and pathological effects of the din that strikes so confusingly and tiresomely upon the ears of visitors from quiet rural villages and farms —effects that undoubtedly impress more or less even those who are unconscious of them—are set forth without much resort to medical technology, and in very interesting form.

For instance, who outside of the medical profession suspects, until authoritatively told, that their failing nervous energy is in large measure due to strain upon the system in the act of hearing. They go to the country for rest. For days afterward they feel like sleeping. The confused babel of sound they have left behind is a foe to sound sleep, and they have found a place where their nature and their need, no longer resisted, invite repose. When "well rested out," they cease to feel sleepy, except in the hours of habitual slumber. This is not alone true of such as work hard with brain or hand. Those who live in luxury have similar experiences. Who in the great city, watching by a life trembling in the balance where sleep, natural sleep (not forced by drugs), is the one thing sought and prayed for, —as the family doctor says, "the most sovereign remedy, but one that is not to be had from pharmacists,"—who has not at some time felt the unnecessary noises in the streets, penetrating the sick room, almost as they would feel blows or dagger-thrusts. Will the noise never stop? By and by, as midnight approaches, the streets become comparatively quiet. The weary, pained eyelids droop, and the delicious saving slumber settles down upon them, when suddenly the distant rumble of some ponderous truck is heard, its noise increasing as it comes nearer, till, crashing unmercifully by, the shock of sound drives away sleep, and the pain-racked sufferer again moans and tosses in anguish.

That a large part of the noise of cities is needless goes without saying. What use does the jangling of bells subserve? Who is benefitted by the cries and horns of street pedlers? Then there are the steam whistles and striking clocks; the barking of dogs; the caterwauling of feline prowlers; the periodical torture of exploding powder-crackers, torpedoes, pistols, and fireworks. All these are arraigned by Dr. Girdner as unnecessary and mischievous. Even the noise of vehicles could be reduced almost to nothing by asphalt pavements and the abolition of the loose manhole cover, of which Dr. Girder says that he knows of no single source of noise so annoying, especially to the sick.

One of "the worst brain-bruising assaults" is the din caused by truck-loads of iron rails, girders, etc., which might easily be avoided by placing pieces of old burlaps between the jarring surfaces.

"The cartman who drives through a street with the body of the cart banging the shafts at every stride of the horse ought to be stopped by the police and made to fasten the body firmly."

A very practical suggestion is made for

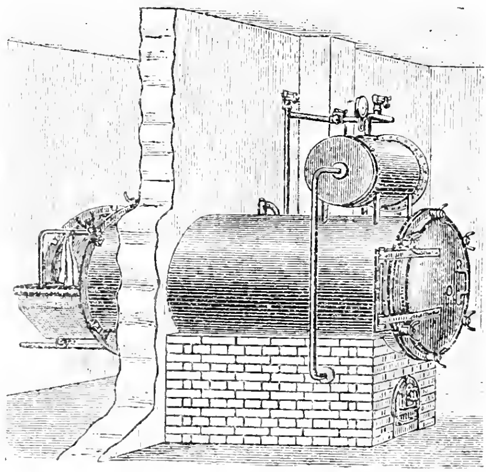
the organization of a society in New York (" Society for the Prevention of Noise " is formulated as an appropriate name for it), to replace the fitful protests of the public press by concerted effort for reform.

" It should have a charter and certain powers and responsibilities conferred upon it by the legislature. It should be modelled somewhat after the pattern of the Society for the Prevention of Cruelty to Animals, or the Gerry Society. It should make a study of the noises of the city, and through its own powers, and by advice and coöperation with the various city departments, suppress such noises as are unnecessary, and reduce those that are necessary to a minimum."

We have no doubt that such a society can be organized, that it could effect the needed reforms, and that it would receive the support of the medical faculty, and the approval and coöperation of the best citizens. The success of such a society in New York would set the pace for similar societies in other cities equally in need of relief from the burden of needless noise.

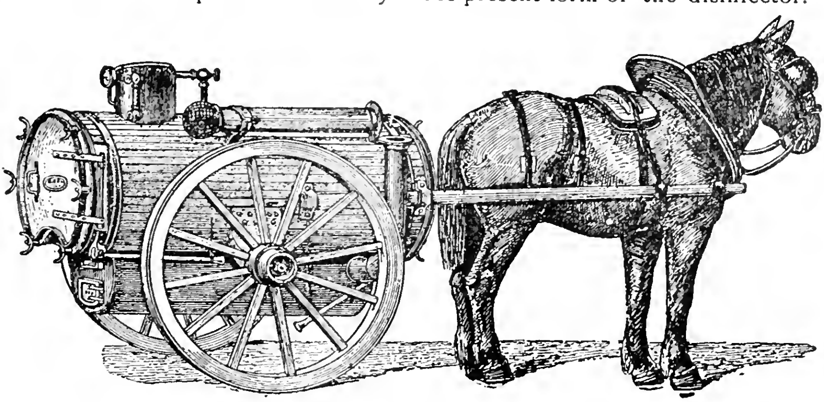
Beck's Disinfectors.

WITH the advance in sanitary science, it has become known that modes of disinfection formerly relied upon do not justify confidence, and appliances for still more thorough work have come into demand. Moist heat is far more powerful than dry heat as a germicide. This was demonstrated by Tyndall in the famous controversy upon spontaneous generation in which he took a prominent part. As a result, steam disinfectors are leading the van now, and one designed by a Copenhagen engineer—Mr. A. B. Beck—combines with cheapness a degree of efficiency that leaves hardly anything to be desired. It is also very convenient in use, and capable of being mounted as a stationary or a portable appliance. We herewith illustrate both arrangements, reproducing the cuts and condensing the descriptive text from *The Sanitary Record* (Aug. 14).



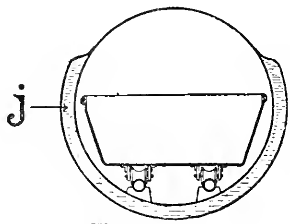
STATIONARY DISINFECTOR.

The original device of Mr. Beck had some disadvantages which are removed in the present form of the disinfector. The essential features of the apparatus are the admission of steam under a moderate pressure into the cylindrical chambers in which



PORTABLE DISINFECTOR.

the articles to be disinfected are suspended, and the subsequent condensation of the steam by a shower of cold water discharged over a screen which, fixed parallel with the upper half of the chamber, protects the articles beneath it from the contact of the water, the latter being run off by a drain in the floor. In the original arrangement the articles were removed to a separate drying-room or chamber heated



Water Jacket.

by a steam coil, where the drying was effected. About a year ago this disinfector was exhibited at the Liverpool meeting of the Sanitary Institute and there experimented with, and it was shown to be competent to destroy all deleterious germs—even spores of anthrax—in fifteen minutes.

The improvements consist, first, in an arrangement which dispenses with this drying closet, and permits of the entire process being carried out in the disinfector itself. This is now made with a water jacket embracing the lower two-thirds of its circumference, which is partially filled and closed by a screw plug. When the chamber is charged with steam, the heat is transmitted to the water, which, by the end of half an hour, has been raised nearly to the boiling-point. The articles having been exposed to the heat as long as is deemed sufficient for complete disinfection, the steam is shut off, and the cold shower turned on, condensing the vapor contained in the chamber; after which the door is partly opened, allowing the moisture in the clothes or bedding to escape as fast as it evaporates, and, by the time that the water in the jacket and the air in the chamber have cooled down to the temperature of the surrounding atmosphere, the articles disinfected may be actually drier, as shown by a small, but appreciable, loss of weight, than they were when first received at the station.

The other improvement is the entire separation of the furnace from the apparatus, no part of which is now exposed to the action of the fire. An ordinary saddle boiler is set in masonry over the furnace, and connected by an ascending and a return pipe with a steam drum fixed above the chamber, and communicating with it by a short pipe fitted with a stop cock, and opening into the roof of the chamber above the screen, as does also that which admits the cold shower, thus avoiding direct contact alike of the steam jet and cold douche with the articles suspended beneath. The boiler, which is the only part of the apparatus likely to require repair, can thus be renewed as often as is necessary by an ordinary workman, without disturbing the rest of the arrangements. These improvements are also introduced into the portable disinfectors, which in their general appearance are not unlike an agricultural steam engine, the only difference between these and the stationary apparatus being that the furnace and boiler are set in an iron frame instead of in brick.

The Great Sea Waves in Japan.

In June the world was startled and horrified by the news that seventy miles of the Japanese coast had been inundated by one of those great sea waves to which the sea is subject in the region of the Japanese group of islands, and that thirty thousand lives were lost in the catastrophe. What is the origin of these waves? Scientific men have assigned causes which seem to be sufficient to account for them, but no one of these has been absolutely verified, and they are, as yet, purely speculative. Seismography has been making progress, however, and the indications are strong that the destructive wave referred to had its origin in a seismic disturbance at the bottom of the sea.

In an editorial upon this subject, in *Engineering* (Aug. 7), it is said that for the best part of a month the British public was led by mails and telegrams to believe that the catastrophe occurred on June 17.

"On that day, however, microseismographs and equivalent instruments were at rest, and, therefore, if the telegrams were correct, a terrible oceanic disturbance which must have been perceptible in all parts of the Pacific ocean had been created without any accompanying movement of the earth's crust. On June 15 Professor Vincincenti, in Italy, noted the commencement of the disturbance, in which there were several maxima which culminated in Japan time at about nine o'clock on the following morning. A similar commencement was recorded at Shide in the Isle of Wight, but, as at a later hour this instrument was dismantled for adjustment,.... a complete record was not obtained.

"These facts so impressed those who were acquainted with the working of such apparatus and its capability of recording disturbances, even if their origin were at their antipodes, that notes were published in *Nature* and the *Times* suggesting that, for unknown reasons, it was likely that our telegraphic information was incorrect. This surmise that Reuter and our newspapers were in error, and that the seismographs were not only right to the minute and the hour, but gave us information as to the number, relative intensity, and the times of occurrence of the successive efforts which created so much destruction, is now an established fact."

Here we have very strong evidence that waves of this character are due to disturbances of the earth's crust.

Our contemporary says that these waves which have from time to time visited Japan have "one and all taken place upon the eastern coast, where the land slopes rapidly downwards beneath the deep Pacific, and where there are soundings of over 4,600 fathoms. The magnitudes of the waves have depended upon the distance of their origin from the shore on which they impinged, on the sizes of the displacements by which they were produced, and on the contour of the coast which was invaded. Some may have coincided with the regular lunar tides.

"The sea waves of 1868 and 1877, originating as they did at a distance approaching 9,000 miles off the South American coast, took nearly twenty-four hours before they reached the coast of Japan, where they rose and fell every ten or thirty minutes, like rapidly-recurring tides. The inhabitants on the coast, naturally alarmed at such a phenomenon, and not knowing the height the waters might eventually attain, fled with their *penates* to higher ground. Although in many places situated near the heads of estuaries with broad openings the water quickly rose and fell through heights of from six feet to ten feet, nothing of the nature of a wave was visible upon the horizon. Nor would such waves, although they were travelling with velocities of from three hundred to four hundred miles per hour,—a rate dependent upon the average depth of the ocean in which they were propagated,—be noticeable upon ships on the open sea. That this might well be so is easily recognizable when we state that, although they might be ten feet or so in height, their length, as measured from crest to crest, approached two hundred miles. These same waves, nearer to their origin on the South American coast, as with the waves of 1896 upon the Japan coast, as they rushed in upon the coast, piled up on shallow shores and the heads of bays, until they burst as avalanches of water from thirty feet to eighty feet in height, to rush inland for a distance of one or two miles, carrying all before them. Just as a steamer going up a river withdraws the water from either shore to form the wave it leaves in its wake, in a similar manner an earthquake wave warns the inhabitants on a shore of its approach by a rapid recession of the water. In Japan, when this recession took place, it was dark, and therefore only seen by a few, some of whom sought refuge on high ground to look back, first, on a bare shore, which, they say, emitted a curious phosphorescent light, and then on the white-capped dusky mass, which swept away all before it. Out at sea the waves were too long to be observed by fishermen, who, in the morning, put back to their harbors to find the sites of their villages represented by masses of sodden débris."

Nitragin.

After a brief summary of the important results of Pasteur's brilliant investigations in the various food-producing industries and in the manufacture of wine and beer, C. M. Aikman, in *The Contemporary Review* for August, discourses upon what is likely to prove one of the most remarkable of these results,—the inoculation of the soil with pure cultures of bacteria, with the object of increasing its productiveness. The general name "nitragin" has been given to these cultures.

Pasteur having shown that all decomposition of organic matter is due to the action of micro-organic life, it is a logical sequence that, as the growth of living plants largely depends upon the products of such decomposition, the action of such living micro-organisms as aid in this work may be brought under control, in a manner wholly analogous to the methods now employed in the making of wines, cider, beer, butter, etc. The supply of the pure cultures necessary has been undertaken by a large German chemical manufacturing establishment, and this fairly inaugurates what is judged by competent men to be an important advance in the science and practice of agriculture.

Of all substances resulting from decomposition of organic materials, nitrogen is the most important of plant foods. Its supply in a form suitable for assimilation by plants has long been recognized as essential to successful agriculture. Although the air contains a large quantity (seventy-three per cent. of its volume) of nitrogen, atmospheric nitrogen is in a form unfit for the food of most plants. Only the leguminous plants can take nitrogen directly from air; clover, peas, beans, etc., are among these plants. In decaying, these plants give off their nitrogen in a form suitable for the food of other plants. The practice of sowing clover and ploughing under the crop as a preparation for a crop of another kind was long practised before the reason for the effect was understood. Recent investigation of the nodules on the roots of leguminous plants has discovered the fact that these nodules are the habitats of micro-organisms which effect the desired fixation of nitrogen, though how this is done yet remains a mystery.

"Living at first at the expense of the plant, as parasites, they gradually become passive, and the cells then become filled with bacteroids or bacterium-like bodies." When this period is reached, the plant absorbs the contents of the nodules. Whether there is only one kind, or a number of kinds, of bacteria that thus act is not yet known.

"The early experiments on a practical scale were made by inoculating soils, on which leguminous crops had been found by practice not to do well, with soil from fields containing the nitrogen-fixing bacteria in large numbers. To effect this satisfactorily it was found that no less a quantity than sixteen cwts. of soil had to be used per acre. This method, besides proving cumbersome, is not free from other objections, since organisms other than the nitrogen-fixing ones—organisms which may exert a distinctly unfavorable action on plant growth, as well as induce fungoid diseases or parasitic growths—may be present in the soil thus applied. Professor Nobbe consequently set himself to obtain pure cultures of the fixing bacteria by the usual bacteriological methods. Inasmuch as the different leguminous crops require, as we have already explained, either separate organisms or else different modifications of the same organism, Professor Nobbe has prepared a large number of pure cultivations suited for the commoner leguminous crops grown. These cultures are preserved in glass bottles containing *agar-gelatine*,—a commonly-used developing medium,—and are of eight to ten ounces' capacity. They have to be kept from the influence of the light, and care must be taken not to expose them to a temperature above 98° F. Inoculation of a soil with these cultures, on a practical scale, may be effected in either of two ways. First, the seed of the crop it is desired to inoculate may be inoculated before it is sown. This is effected by making a watery solution of the pure cultivation, immersing the seed in it, and subsequently drying it; or, secondly, it may be effected by inoculating a quantity of fine sand, or earth, in the same way, and then spreading it over the field, and subsequently working it into the soil to a depth of about three inches.

"Naturally, a point of considerable interest is the economic question of the cost of such treatment. It is interesting to learn that this is extremely moderate, as the expense of inoculating a field in this way amounts to the very modest sum of five shillings per acre. This cannot be regarded as expensive, and contrasts favorably with the expense of nitrogenous fertilizers.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

†7576. Nitragin: An Important Advance In the Science of Agriculture. C. M. Aikman (A description of the latest application of the principle of inoculation in agriculture—the inoculation of the soil with pure cultures of bacteria for promoting plant growth). Contemporary Rev-Aug. 2000 w.

7587. Deleterious Effects of X-Rays on the Human Body (Editorial account of physical effects upon H. D. Hawks, who has been giving exhibitions with an unusually powerful X ray outfit). Elec Rev–Aug 12. 450 w.

7588. Roentgen Rays or Streams. Nikola Tesla (A summary of observations previously made, with arguments to show that these rays consist of streams of matter in some primary condition). Elec Rev–Aug. 12. 2500 w.

7595. A New Light for Photographers. C. F. Townsend (Illustrated description of the new light "*La Lampe Caton*"). Sci Am–Aug. 15. 1100 w.

7596. The Sardine Fishing Industry in New Brunswick. Prof. Prince (From the report of the Department of Marine and Fisheries. An interesting description of an important industry). Sci Am Sup–Aug 15. 2500 w.

7597. Industrial and Trade Schools in Germany (Digest of report by Mr. L. R. Klemm, of the Bureau of Education, Washington, D. C). Sci Am Sup–Aug. 15. 2400 w.

7598. $250 Prize Essay Composition—The Progress of Invention During the Past Fifty Years. Fourth Prize, won by (Semper Fidelis) Gardner D. Hiscox (An excellent historical review). Sci Am Sup–Aug. 15. 3200 w.

†7615. India as a Field for Investment.—Tea (The purpose of this article is to show that with modern improvements in appliances for cultivating, harvesting and curing tea, the East India tea industry offers a remunerative investment to those who may wish to engage in it). Ind & East Eng–Aug. 1. 2800 w.

*7657. The Great Sea Waves in Japan (Editorial discussion of the seismic disturbance which caused the inundation of the northern Japanese coast in June, and the resources of engineering science which may help to avert the great destruction caused by such disturbances). Engng –Aug. 7. 2500 w.

*7660. New Zealand Timber (Editorial, calling for efforts to stimulate trade between Britain and distant parts of the empire, and calling attention to New Zealand timber as a promising opening for such trade, with particulars relating to kinds and value of timber available). Engng –Aug. 7. 1300 w.

*7682. The Röntgen Rays. J. J. Thomson (Abstract of the Rede lecture, given at the University of Cambridge. A general dissertation upon the facts and current theories of the Röntgen rays, and their probable future as a means of physical investigation). Elect'n–Aug. 14. 2800 w.

7717. Past and Present Tendencies in Engineering Education. Mansfield Merriman (Presidential address before the Society for the Promotion of Engineering Education. An elaborate article touching upon nearly all the aspects of the question). R R Gaz–Aug. 21. 3200 w.

7729. Practical Solution of Fourth Degree Equations. George B. Grant (The process described is one of simple substitution in formulæ involving much work which however is of a simple character). Am Mach–Aug. 20. 600 w.

7753. Nansen's Polar Expedition (Interesting outline of the expedition from beginning to the arrival of the explorer at Vardoe. Map). Sci Am–Aug. 22. 1200 w.

7800. The Absolute Zero (Explanation of the term, how it is determined, etc., with diagrams). Am Elect'n–Aug. 500 w.

7805. Use of Photography in Data Collections. Reginald A. Fessenden (Illustrated description of apparatus and rapid method for the photographic copying of indexed data from books, pamphlets and periodicals, with list of material needed). Elec Wld–Aug. 22. 3000 w.

†7876. Optical Mineralogy. Lea McI. Luquer (Treats of a system of microscopical examination for the accurate determination of rocks). Sch of Mines Quar–July. 10000 w.

†7882. The Plague of City Noises. J. H. Girdner (The deleterious effect of confused noises upon sight and hearing, the needlessness of many city noises, and means for abating them are considered). N Amer Rev–Sept. 2800 w.

†7883. An Industrial Opportunity for America. E. Sowers (The opportunity discussed is the manufacture of beet sugar, and the history and progress of this industry in other lands are made use of in an argument urging the extension of beet culture to parts of the United States named as favorable). N Amer Rev–Sept. 3300 w.

*7886. Coffee Growing in Peru (Illustrated general description of the industry, as conducted in the valleys of Chanchamayo and Perené). Engng-Aug. 21. 3000 w.

7905. A Completed Chapter in the History of the Atomic Theory. Edward W. Morley (Address by the retiring Pres. of the Am. Assn. for the Advancement of Science. Prout's hypothesis made in 18 5, and accepted as probable by some eminent chemists,—that the atomic weights of other elements were probably divisible by the atomic weight of hydrogen taken as unity, is held to be so completely disproved by modern research that it must be abandoned. The proofs of its falsity are given and other lines for the study of atoms are suggested). Science-Aug. 28. 8000 w.

†7906. Bacteria and Carbonated Waters. G. C. Frankland (A statement of discrepancies in the results and conclusions of different observers, upon the hygienic importance of gaseous aeration of water from a bacterial point of view, is followed by a statement of the behavior of pathogenic bacteria in such water, upon which the results show much better agreement). Nature-Aug. 20. 1600 w.

*7907. A Research on the Liquefaction of Helium (Translated from the original paper by Prof. K Ol-zewski, in the *Bulletin de l'Académie des Sciences des Cracovie* for June, 1896, "Ein Versuch, das Helium zu verflünigen." by Morris Travers Description of apparatus, method and results). Nature-Aug. 20. 1800 w.

*7908. On Periodicity of Good and Bad Seasons H. C. Russell (Abridged from a paper read before the Royal Society of New South South Wales. Results of systematic observation showing periodicity in the weather, floods and droughts). Nature-Aug. 20. 2800 w.

*7937. The Nomenclature of Asphalt and Mineral Bitumen or Pitch. Leon Malo (The distinctions between asphalt and bitumen are set forth and the nomenclature published in the *Annales des Ponts et Chaussées*, in 1861, is confirmed). Munic Engng-Sept. 1500 w.

7970. Machine for Solving Numerical Equations. George B. Grant (Illustrated description which gives rough approximations to roots of numerical equations, and competent to give the integral figures of roots of the general equation of the fourth degree). Am Mach-Sept. 3. 1100 w.

7983. Open Hearth Furnaces in Glass Works. From *La Nature* (Illustrated description). Sci Am Sup-Sept. 5. 1400 w.

7986. On the Comparison of Low and High Vacuum Electrical and Radiant Matter Phenomena with the Aurora, the Solar Corona, and Comets. Wallace Gould Levison (Abstract of a note read before the New York Academy of Sciences. Auroral phenomena explained; comets regarded as aggregations of radiant matter. The solar corona is also referred to the same category). Sci Am-Sept. 5. 1800 w.

†7992. On the Regular or Specular Reflection of the Röntgen Rays from Polished Metallic Surfaces. O. N. Rood (Results with different materials and different forms of reflectors). Am Jour of Sci-Sept. 3200 w.

†8022. Estimation of Thoria. Chemical Analysis of Monazite Sand. Charles Glaser (An account of preliminary experiments in a general investigation relating to the best methods of estimating the percentage of thoria, recently become of high commercial importance). Jour Am Chem Soc-Sept. 3300 w.

†8062. Production of Coffee in Mexico (A full description of the industry in reply to numbers of letters of inquiry). Cons Repts-Sept. 10800 w.

*8069. The Eclipse of the Sun. J. Norman Lockyer (An account of the expedition to Kiö Island, to observe the last solar eclipse, with its results. Illustrated). Nature-Aug. 27. Serial. 1st part. 4400 w.

*8070. Large Explosions and Their Radii of Danger. J. T. Bucknill (This investigation has for its object the affording of data for legislation directed to the safeguard of property from danger caused by the traffic in and storage of explosives in large quantities). Eng-Aug. 28. Serial. 1st part. 2200 w.

*8071. The Engineering Department of the Yorkshire College, Leeds (Illustrated description). Engng-Aug. 28. 2000 w.

*8075. Timbers in the Straits Settlements. Henry J. Child (Paper presented to the Assn. of Surveyors of H. M. Service. A very compact summary of the names, qualities, and uses of different kinds of timber. Most of the timbers named are entirely unfamiliar to the American people). Engng-Aug. 28. 1400 w.

8083. The Transmutation of Silver into Gold (Correspondence on this subject between the editor of the Eng. & Min. Jour. and Dr. Stephan H. Emmons, who was announced in several N. Y. papers as having discovered a chemical process by which silver could be transmuted into gold). Eng & Min Jour-Sept. 5. 3500 w.

†8102. Origin and Age of the Laurentian Lakes and of Niagara Falls. Warren Upham (Presented before the Geol. Soc. of Amer. and Section E. of the Am. Assn. for the Advancement of Science. The preglacial condition of the St Lawrence basin, changes bringing on the ice age, recession of the ice sheet, glacial lakes, beginning of Niagara River, variations of the volume, duration, &c). Am Geol-Sept. 3000 w.

8112. The Andrée Polar Expedition (Illustrated description of Andrée's balloon, and balloon house, in Spitzbergen). Sci Am Sup-Sept. 12. 1000 w.

†8119. The Philosophy of the Pneumatic Tire. Reprint from the *N. Y. Sun* (An interesting explanation of the action of pneumatic tires on various kinds of roads, with comparison with the cushion tire). Ind Rub Wld-Sept. 10. 2400 w.

†8120. The Production and Use of Dental Vulcanite. W. Storer How (Directions for making a fine, strong, solid, odorless vulcanite denture). Ind Rub Wld-Sept. 10. 1000 w.

†8121. American and Foreign Rubber Facts in Figures (Statistics of interest to the rubber industry, with editorial comment). Ind Rub Wld-Sept. 10. 1500 w.

COMMENT & CRITICISM

That $15,000 Experimental Engine.

In my article on "Quackery in Engineering Education" I advanced certain views in regard to that "$15,000 experimental steam engine." Some statements questioning the soundness of these views have appeared in your pages; none of them, however, seem to have emanated from a steam engineer. As another of these machines was recently added to a college equipment, and no doubt the near future will witness new demands for funds to increase their number, it will not be inopportune to state why I consider such an investment unwise.

As a piece of laboratory apparatus a steam engine is of value for but two things: (1) to illustrate principles and to teach correct methods of adjusting, operating, testing, etc.; (2) to conduct original researches. As to the first, everything of consequence can be taught by a competent man from an engine costing not more than $700; in fact, a considerable portion of the work can be better taught from a small than from a large engine. A small machine running at three hundred and fifty revolutions is far more difficult to indicate than any large engine; hence it affords better practice. Similarly, all essential operations on valve-setting, testing, etc., can be learned just as well from a 10 × 24 Corliss as from the largest size built, and more quickly at that, as the student wastes no time on a lot of pieces heavy enough to impede his work, but not warranting an outlay sufficient to provide ample mechanical means for handling them. In regard to care and management a large engine would certainly afford valuable experience that could not be got from a small one. It is questionable whether in a school such experience can be got to an extent worth considering; but, if it can, this fact proves nothing for a single one of these triple expansion experimental engines. All within my knowledge are of the Corliss type, hence slow speed; some were designed to develop only 100 h. p., others 150, and the largest of them has cylinders 9, 16, and 24 inches, by 30 inches stroke. This machine is entirely too small to give the kind of experience just mentioned, and does not require for its management as much vigilance and knowledge as would be demanded by a smaller engine running at a high speed. This is too well known to every steam engineer to need further discussion.

Apart from show, the real purpose of these machines is found in that word "experimental." Experiments are valuable for two purposes only: (1) to illustrate known facts; (2) to discover new ones. The former can, sufficiently for all purposes of instruction, be achieved on a single cylinder engine. The latter, then, is the real object. One school says: "This engine is designed to run single, compound, triple, and will be provided with brakes, condensers, etc., whereby *exhaustive experimental tests may be made.*" Another states: "The arrangement of the accessory apparatus is sufficiently complete to permit *a close study of all the finer problems affecting the performances of steam engines.*" I respectfully dissent from these views, because none of these engines reflect conditions found in practice; hence tests on them fail to furnish data that can safely be used in practical problems, except *perhaps* in a limited number of cases. I cannot recall a single case in practice where the installing of a triple-expansion Corliss engine equal to the largest of these school machines would not be a serious mistake. Nor will it help matters to say that small triple-expansion engines are used in marine work, and, very rarely, on land, since all these are high-speed engines, working under heavy pressure, and of a design wholly different from that of the engines under discussion. To apply to them, without further experimentation, any conclusions drawn from tests on these Corliss engines would be a palpable error of judgment. It therefore seems that, from the very design of these experimental engines, nearly all results got from them will be *sui generis;* hence of little practical value. Nor can these machines be of any great use in the "attempt to teach the theory and practice of compounding, jacketing, and *all the many other details* entering into the economy and management of modern large power units," since they themselves are neither large power units or a form which any engineer would use. To talk of teaching the "theory and practice of jacketing" by means of such a machine is ludicrous. The engineering world is anxiously looking for the man who can do this on any engine. The status of the steam jacket is by no means settled, nor can any number of experiments on such engines, or dozens of regular working machines, furnish sufficient data to settle it, as is clearly shown by the "Report of the Research Committee of the Institution of Mechanical Engineers on the Value of the Steam Jacket." (Oct. 26, 1892.)

After laboring nearly six years, this committee, composed of the foremost English experts, "do not appear to have arrived at any very definite conclusions." Comment is unnecessary.

I therefore fail to see what really valuable results can be got from experimental engines of a size and design used by nobody outside of technical schools. I believe that, up to the day they land in the scrap-pile, they will contribute far less real information than can be got from a few careful and exhaustive tests on engines of a size and type in general use. That they are excellent for the spectacular I can readily see, but I still consider it an educational and business mistake to divert from better uses the $9,000 needed to instal that "$15,000 experimental steam-engine."

EDGAR KIDWELL.

Michigan Mining School, Houghton, Mich., September, 1896.

Are British Railroads Good Investments?

MAY I ask a little space to make a few remarks upon the reply of Mr. W. J. Stevens (in your August number) to my article on British railroads as investments (in your May number), as it is evident that Mr. Stevens has no treally touched the principal point of my criticism.

My proposition was that British railroads, at the prices for their stocks which ruled in March last, when my article was written, were not good investments. I showed that they were being bought to yield (on the basis of the 1895 dividends) about 3¼ to 3⅜ per cent. on the ordinary stocks, 2¾ per cent. on the preferred stocks, and 2½ to 2¾ per cent. on the debenture stocks. I argued from this that, with so low rates of return on the investment, there must be great security of yield, and at least a reasonable prospect of increase of yield; and I asked whether this security existed in the case of British roads. In endeavoring to answer this question, I showed that, between 1885 and 1894, capitalization increased faster than did mileage or net earnings, and that the rate of return on capital had consequently decreased. I showed further that in this period operating expenses had absorbed almost all the increase in gross earnings, and that the increase in operating expenses appeared to be almost entirely in items other than those of "maintenance." In point of fact, wages, rates, and taxes accounted for the entire increase. I pointed out that enormous additions to capital account, which did not produce a corresponding return of net revenue when coincident with relatively decreased expenditures, naturally led to the question whether "new equipment" and "improvements" were not taking the place that should have been filled by "maintenance of equipment" and "maintenance of way" expenditures, charged to operating cost.

On that I rested my case against these roads as investments, on the ground that the time must come some day when "construction" and the issue of new capital must cease, and then operating expenses must increase, to the detriment of dividends.

Mr. Stevens's reply states the case as follows: Since 1894 (the year chosen by me for comparison as the latest for which board of trade statistics were available) there has been a great recovery in British railroad earnings and a general increase in dividends, which bids fair to continue in progress. Furthermore, that, after allowing for nominal additions to capital from conversions and so on, the return on actual capital invested would have been over four per cent. in 1894. Furthermore, that, although the increased main line mileage in ten years is only 1,739, there has been considerable increase in third and fourth track mileage. Furthermore, that the railroads are able to borrow fresh capital now at 3 per cent. or less, and consequently do not require to maintain the same "overhead return" that they did. Furthermore, that the increase in wages, rates, and taxes has now been arrested, that the decrease in cost of materials in "maintenance of way and equipment" is due to lower prices for supplies, and that the increase in wages of shop and track employees has been relatively much smaller than that of engineers, switchmen, conductors, and other employees in the transportation departments. Furthermore, that the scarcity of investments of a high class leaves investors nothing else to buy but "home rails," which are especially attractive in view of the increasing earnings, good management, freedom from competition of a reckless kind, and the fact that capital largely represents money paid in in excess of the nominal amount of the stock. This is a fair statement of Mr. Stevens's case.

I am not conscious of having omitted any of his contention. It will be at once noticed that this argument chiefly rests on the fact that there has been a general recovery in business in 1895 and since, which, he thinks, will continue, and of course during its continuance dividends will be maintained, and perhaps increased. As regards expenses, his claim is that wages, rates, and taxes have increased heavily, while cost of materials has decreased, except for fuel, and he endeavors to explain the absence of relative increase in maintenance expenditures on this ground.

In this he does not touch the main point of my criticism, which was that the tendency of capital expenditure to increase without a corresponding increase in "maintenance expenditures" or net earnings argued something wrong in the theory of management, and suggested that capital was doing the work of "maintenance" charges. I never suggested that British railroads would not have periods of prosperity again, when dividends would increase. I did say that they would some day have to face the permanent closing of "construction account" and permanent increase in expenses, and that for this reason they were not good investments at prices based on open "construction accounts" and very cheap money in a time of prosperity.

I have on this point a witness to produce, whose credibility and knowledge will not be disputed by Mr. Stevens. It is a little book dated 1896, entitled "Home Railways as Investments," by Mr. W. J. Stevens. I present the following extracts therefrom:

"Though among the large companies from half a million to a million is frequently spent upon this (*capital*) account during the six months, the fact is generally diminished by the chairman at the half-yearly meeting by a bare mention of the figures, while with the most minute details he wearies the shareholders with inconsequent remarks and figures relating to all the items of revenue. . . . . "

"The other weak point in the financial position of our railways is the rapid increase in capital. The theory upon which our railways work is to charge to revenue all that is necessary to keep the line up to its original standard of efficiency, and to charge practically every addition to its rolling-stock and the cost of all improvements and extensions of their systems to capital accounts. . . . . It is obvious that such a theory, if not acted upon very strictly, may lead to serious abuses. Even to act up to it to the letter is hardly judicious in all circumstances, and this is what most companies do. . . . . In fact, the question is not how little can be charged to capital but how much."

"Had a proper policy been pursued from the first, there is no doubt that the ordinary stocks would be in a much better position than they are, for fixed charges would have been very much lower than at present."

"The superiority of the London and Northwestern reflects itself in this important item (*capital outlay*), and, though it is more free with its capital expenditures than, taking all probabilities into account, could be wished, it is much more strict in its charges to capital account than most other companies. For years past it has charged nothing whatever to capital account in respect of law and parliamentary expenses, defraying all these out of revenue, contrary to the general practice." "Since 1889, though the (*Midland*) wagon stock has been continuously on the increase, the amount charged to revenue for the maintenance of that stock has declined year by year, until it is now £170,000 below the figures of 1889. . . . . Besides, if we go back to 1880, before the purchase of wagons began, it will be found that, on its then stock of over 32,000 wagons, it charged to revenue an average of about £5 per wagon for repairs and renewals. In 1895 the average charge was only a trifle more than half that,—*viz.*, £2.12s.0. It is more than likely that the Midland is, through a somewhat roundabout progress, deriving a considerable benefit to its revenue from the fact that large sums have been paid out of capital for the purchase of mineral wagons during recent years."

"One of the strongest points about the Northeastern is the excellent provision it makes out of revenue for the maintenance of its permanent way and repairs and renewals of its rolling-stock of all kinds."

"In the case of English railways it is very difficult to draw the line between what are revenue and what are capital wages, and the division in a great many cases where the circumstances are otherwise similar will depend a good deal upon the financial condition of each company. With an open capital account, the danger of directing revenue charges thereto, is an ever present one, and one of the very easiest possible methods of doing this is by making inadequate charges against revenue for the maintenance of the road and rolling stock."

I could find more statements of the same kind in Mr. Stevens's book,—which, by the way, is an excellent manual for all interested in British railroads,—but the above are more than sufficient. Indeed, if I had had Mr. Stevens's book in my possession before I wrote the article in the May number, I should have felt obliged to credit Mr. Stevens with the whole argument. He is about the last man that I should have expected to dispute my contentions, for his book goes far to prove them up to the hilt.

"One more quotation, and I have done:

"No doubt there is a certain element of danger in the feature that low money rates have contributed to the declining yield and relatively high prices of home railway stocks generally. But, allowing for all contingencies in the direction of dearer money, there seems no doubt that the return on home railway stocks has been permanently reduced. Furthermore, there is the prospect that improving dividends will more than counteract the possible adverse influence on prices of dearer money rates. At the same time it is doubtful if ever before the market for home railway stocks was so liable to be influence by the course of events in the money market."

Bursts of prosperity may mask unprofitable expenditures of capital and insufficient charging of revenue for a time; cheap money may force investors and speculators into British railroad stocks at the high prices; there may be an almost inexhaustible supply of money yet to be expended on the railroads. These do not alter the facts, and sooner or later—and a rise in the value of money may bring it sooner than many think—the facts will show themselves. If they are as I suppose them to be, and as Mr. Stevens's book already shows them to be, there will be an end to capital expenditures, and a very appreciable rise in the rates of operating expenses. With money worth three or four per cent., and with dividends below the present basis, where will investors at present prices in British railway stocks then be?

THOMAS F. WOODLOCK.

August, 1896.

Ashes as a Source of Municipal Revenue.

As the inventor and maker of bricks made from ashes, I desire to reply to your interesting article (p. 979, August number) upon the above subject.

My namesake (not a relative, and since deceased) some years ago brought out a "destructor" to cremate scavenging refuse, but achieved only partial success, two-thirds of the rubbish even then needing treatment.

In the face of this, why not deal with the whole of the material as collected, and turn it to advantage, instead of following the cumbersome, expensive, and wasteful system of destruction?

Briefly, the mode I employ is:

(1) Lime is scattered upon the refuse as soon as tipped, to prevent the exhalation of noxious smells.

(2) Everything is ground together with lime, excepting what can be profitably disposed of,—such as metals, leather, and rags.

(3) The resulting mixture is moulded into bricks and blocks.

Recently the subject has engaged the attention of the South Wales Institute of Engineers, in which body it was suggested that my samples should be tested to see what crushing strain they would bear.

This duty was readily and kindly undertaken by Professor Elliott of University College, Cardiff, who used the splendid testing machine at the Technical Schools there, with the result that a brick made two years ago gave a higher crushing record than many stones with which the professor had previously dealt. Bearing in mind the relative ages of the two substances, stone and my material,—thousands of years as against months, there can be no doubt whatever that, properly made and mixed, a good, salable article can be produced from what is now a costly bugbear to municipal authorities.

I may here remark that no burning is required whatever, the composition setting, like cement; and I use the bricks and blocks (the latter 9″×9″×12″), as soon as they will bear carriage, in houses which I am building.

Col. George E. Waring, Jr., is to be commended for bringing so important a subject under the notice of the municipal authorities of New York, but it appears to me that that gentleman, having started on the right road, has deviated from his course, and so missed the goal.

As to the value of ashes, I go with Col. Waring; but, when he states that the mixture of garbage makes ashes unfit for useful purposes, we part company. For instance, the component parts of vegetable matter generally are potash, water, and coloring matter. What objection, then, can there be to this material, when decomposed by lime? and so with fish, wherein is obtained a form of phosphate of lime.

In fact, the whole list of garbage can be regarded as so much useful matter, when in combination with lime.

Bricks made in America have utterly failed under the weather-test, while my bricks successfully withstand the weather; may not the failure of the former arise from the separation of the garbage from the ashes, thereby preventing the various chemical combinations from being set up?

To those who attach but slight importance to chemical changes, I would suggest that they make it a matter of inquiry why:

(1) Spontaneous combustion takes place in some ash-heaps; (2) Without spontaneous combustion in other ash-heaps, everything, barring ashes and precious metals, disappears.

JOHN T. FRYER.

Locksbrook Mills, Bath, August 24, 18

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Rose Polytechnic Institute, Terre Haute, Ind., U. S. A.=(a) General catalogue 1896. (b) Department of Engineering, course of study and faculty. (c) Department of Electrical Engineering, etc. (d) Department of Chemistry, etc. (e) Department of Mechanical Engineering. Laboratory and shop outfits are described.

American Boiler Company, Chicago, Ill., U. S. A., and New York.=Catalogue of steam and hot-water heating apparatus, radiators, valves, pipe, fittings, etc., including the "Non-Drip automatic" radiator air valves, "Perfection" and "Royal."

L. Metesser, New Orleans, La., U. S. A.= (a) Pamphlet illustrating and describing the Cahill Vertical water-tube boiler. (b) Pamphlet illustrating and describing the Metesser gas producer-regenerative furnace for the consumption of low-grade fuels.

Mast, Foos & Co., Springfield, Ohio, U. S. A.=Latest catalogue and price lists of force-pumps, iron turbine wind engines. Columbia steel wind mills, steel wind mill derricks, etc., etc.

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Otto Goetze, New York.=Pamphlet containing opinions of leading firms on manocitin as a rust preventive. Sent free on application.

Watertown Engine Co., Watertown, N. Y., U. S. A.=Leaflet illustrating and describing the Watertown steam engines.

Illinois Malleable Iron Co., Chicago, Ill., U. S. A.=Steam Catalogue, 1895, 372 pp., illustrating and describing an extensive and complete line of malleable and cast iron fittings for water, steam and gas, and steam fitters, engineers, natural gas, and water-works' supplies, engine trimmings, general mill and shop supplies and tools for steam fitters, gas fitters, machinists, etc.

Kalamazoo Radiator Co., Chicago, Ill., U. S. A.=Catalogue and price list, 13 pp., illustrating and describing the "Kalamazoo steam and water radiators.

American Industrial Publication Co., Bridgeport, Conn., U. S. A.=Catalogue of publications relating to science, civil, mechanical and electrical engineering, arts, trades, and manufactures.

The Buckeye Malleable Iron and Coupler Co., Columbus, Ohio, U. S. A.=Pamphlet illustrating and describing the "Little Giant Buckeye Coupler" for freight, passenger, and tender equipment.

The Adams Co., Dubuque, Iowa, U. S. A.= Illustrated catalogue of Farwell's milling attachment for iron planers.

J. H. McEwen Manufacturing Co., New York.=Elegantly illustrated catalogue of engines and dynamo-electric machinery, with diagram of efficiency.

John Stark, Waltham, Mass., U. S. A.=Illustrated descriptive catalogue of bench lathes, and an extensive line of watch-makers, lathes and tools.

Oneida Manufacturing Chuck Co., Oneida, N. Y., U. S. A.=Illustrated catalogue of lathe and drill chucks.

University of Nebraska, Lincoln, Neb., U. S. A.=Announcement of the School of Mechanic Arts.

American Boiler Co., New York-Chicago.= Handbook of useful information, price lists, etc.

Newton Machine Tool Works, Philadelphia, Pa.=Illustrated catalogue of new boring, drilling, and milling machines.

The National Chuck Co., New York.=Catalogue illustrating and describing "National" lathe chucks, "Errington" tapping attachments, etc.

The Philadelphia Steel Roofing Co., Philadelphia, Pa.=Pamphlet illustrating and describing steel roofing, siding fire-proof lath, paints, cements, etc.

F. E. Reed Co., Worcester, Mass., U. S. A. =Illustrated catalogue of lathes and other machine tools.

Cleveland Twist Drill Co., Cleveland, Ohio, U. S. A.=Elegantly printed and illustrated catalogue and price lists of "Increase Twist" drills, self-feeding reamers, milling cutters' end-mills, arbors, etc.

John Platt & Co., New York.=Pamphlet illustrating and describing "Thornycroft" water-tube boilers.

Ford & Bacon, Engineers, New York-Philadelphia-New Orleans.=Large illustrated pamphlet entitled "Recent Engineering Work," reprinted from the *Street Railway Journal*, and describing the system of The Orleans Railroad Co.

Hilles and Jones Company, Wilmington, Del., U. S A.=Illustrations of new and special machine tools, and recent designs for working iron and steel plates, bars, and structural shapes.

The Hawley Down-Draft Furnace Co., Chicago, Ill., U. S. A.=Voluminous pamphlet, containing full exposition of the principles of the "Hawley" down-draft furnace, its applications to the prominent water-tube boilers now in use, and numerous illustrations, testimonials, etc.

William E. Quimby, New York.=Illustrated and elegantly printed pamphlet, describing the "Quimby Screw Pumps," the applications wherein their operation has been most satisfactory, etc.

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THE INDUSTRIAL EFFECTS OF FINANCIAL ISOLATION.

By Logan G. McPherson.

THE red volumes issued by the department of State, entitled "Commercial Relations of the United States with Foreign Countries," show, with abundance of statistics and detail, that there is not a country upon earth that the United States does not export to or import from. In broad channels there is the surge of commerce between our harbors and the ports of Europe: along lesser veins and arteries the fruits of our fields and factories flow to remote corners of Asia and Africa, whence come to us rare foods and fabrics. There is this ebb and flow of commerce between the nations, because one people produce that which another people want. We buy what we need, and sell to others what they need.

The most prosperous country—the country which can support in comfort the largest population in proportion to its area, and draw to its shores the largest volume of the world's natural and potential wealth—is that which can best supply the demand for those manufactured articles whose production requires the exercise of skill and labor, and whose value, therefore, includes the largest possible component portion of labor cost. The production of such articles means the establishment of manufacturing and industrial concerns involving the employment of the engineer and technician for their installation and management, for the construction and control of the vast net-work of land and water ways which they require, and for the design and supervision of the almost infinite extent of public and private works connected with them, or with the life and health of the population which they support. The engineer, therefore, using the term in its broadest sense, is vitally interested in every question affecting the commerce of the country. No stronger illustration is needed than the sudden contraction of engineering enterprise during the past four years of financial agitation. Should the same unfortunate conditions prevail for another four years, the results, to the engineer, could be nothing but stagnation and disaster.

This desire to sell and this desire to buy link the peoples of the earth in bands of mutual advantage that have been forming with strengthening clasp for more than three thousand years. A current map of the vessel routes of the world is a lace-work of lines that cover the ocean, and inland maps are likewise laced with lines that mark the railways. As commerce has increased, civilization has increased. Indeed, "no general and permanent progress of civilization is possible, unless it is based on economic improvement." The increase of inland commerce in the middle ages led to good roads and strong bridges; to persistent attacks upon the robber barons and the outlaws; to the extension of a uniform system of law and its enforcement; to the broadening of interests beyond the narrow limits of the immediate neighborhood; and, not least, tended constantly to bring the separate currencies of the numerous petty States into a definite relation approaching uniformity. "The introduction of better conditions in these respects was almost in itself the transformation of the medieval into the modern," and the ceaseless war of the medieval merchants against barbarism is akin to the war which commerce, consciously or unconsciously, through its participants, wages against barbarism at all times and in all places. The food, clothing, and implements, the articles of use and ornament, that comprise the merchants' wares contribute to the comfort and the fullness of the lives of those into whose possession they come, and those concerned in the production and distribution of the wares of commerce receive a beneficent training and discipline in the virtues of concentration, endurance, foresight, and honesty. The ministering to others' needs necessarily based upon an apprehension of others' wants leads to that breadth of mind and character which is given by the appreciation of the customs and habits that have grown around other peoples and the extent to which they form their lives. And therefore is needed no argument to sustain the proposition that every improvement of whatever nature that tends to develop and increase the commerce of the world is a benefit to all concerned in that commerce.

It is a matter of history that, whenever people have progressed beyond mere barter to constant and considerable exchanges, it became necessary for them to use some commodity as money; and, as the members of one group progressed to the exchange of commodities with the members of another group, there was the tendency to the use by both groups of the same commodity as money. This tendency, increasing as the exchange became general and interracial, led to the use among the different races of the same commodity as money.

Because of their peculiar fitness, gold and silver supplanted other commodities for this purpose. They were so used by the Caucasian races before the beginning of the Christian era; their use increased and extended during the development of medieval commerce; and they form the currency, or are the recognized basis of the currency, of every civilized or semi-civilized nation of the earth to-day. Because of its possessing greater value in less bulk and greater stability of value, gold has tended among the nations whose commerce is the most highly developed to supplant silver as the standard of value and as the recognized basis of the paper representatives of value, comprising circulating notes, promissory notes, drafts, and bills of exchange.

As the adoption of the most valuable commodity as a means of exchange and the standard of value is coincident with the increase in the production and distribution of commodities, it follows that the most valuable means of exchange is used in those communities that are the best fed, the best clothed, the best housed. That is, the use of the most valuable means of exchange is characteristic of an advanced civilization. It cannot be denied that England, France, Germany, and the United States, in which the gold standard is dominant, are in the forefront of civilization, while the barbarism of China is indicated by the fact that its four hundred million inhabitants, in their daily transactions, use almost exclusively the copper "cash," one thousand of which are about equal in value to one Mexican dollar.

It is evident that, if the monetary systems of any two countries were based upon the same standard of value, and if their coins were of the same weight and fineness, the exchange of commodities between them would involve no complications, in so far as the kind of money to be paid in each transaction is concerned. Buyer and seller would have to consider only the amount of money. Approximating such a nature are the transactions between the United States and Canada, the dollars of one country being equal to the dollars of the other.

When the monetary systems of two countries are based upon the same metal as the standard of value, but the coins of one country do not correspond in weight and fineness to the coins of the other country, the buyer in one country and the seller in the other must consider the value of the money of the one country as measured by its value in the money of the other country. Of such a nature are the transactions between England and the United States, the value of the dollars of the one country bearing a fixed ratio to the pounds of the other. When the monetary systems of two countries are based upon different metals, the estimation of the value of the money of one country as measured by the value of the money of the other country would not be more difficult than if the money of the two countries were based upon the same metal, provided the values of the different metals bore a fixed and constant ratio to each other. But this relation does not obtain between the currencies of any two countries that are based upon different metals as the standard of value. The gold coin of a gold-standard country is but merchandise in a country having a silver standard, and the silver coin of a silver-standard country is but merchandise in a country having the gold standard. And gold and silver, particularly silver, are subject to fluctuations in value, the same as other merchandise is subject to fluctuations in value. In each transaction between a buyer in a gold-standard country and a seller in a silver-standard country, or *vice versa*, must be taken into consideration the amount of silver which the gold of one country will purchase, or the amount of gold which the silver of the other country will purchase. This would not be difficult if, in each transaction, the exchange of gold or silver and the exchange of merchandise were instantaneous. But the seller must always consider what value the money to be paid him will possess at the time when he receives it. Upon the accuracy of his foresight depends his gain or loss by reason of the fluctuation in value which the money of payment may undergo in the intervening time, and it follows that, the greater the possibility of fluctuation in the value of the money of a country, the more hazardous is the conduct of business with that country, and the more does such business partake of speculation. If the currency of a country is composed of circulating notes more or less depreciated, rising and falling in value as measured by coins of one or another metal that may nominally be the standard of value in that country, in each transaction must be calculated the value of the depreciated currency in the coin of the country, and the value of that coin in the coin of the other country. The fluctuations of the paper currency as measured by the coin of the issuing country, and the fluctuations of that coin as measured by the coin of the other country, by greatly increasing the risks of commerce with the country having the depreciated paper currency, tend to give that commerce the character of gambling, and to prevent merchants from engaging in it who can dispose of their wares elsewhere.

Were coin actually transferred from one country to another in payment for every transfer of merchandise, vast quantities of coin would always be in transit, and, during the period of transit, commerce would be deprived of its use as money. With the growth of international commerce, has, therefore, developed an economy in the use of coin similar to the economy in the use of coin in the domestic commerce of a country having a developed banking system.

As in domestic commerce the use of checks and drafts largely obviates the shipment of money, so in foreign commerce the use of bills of exchange largely obviates the shipment of money.

The great volume of international commerce causes a great number of bills of exchange to be continually offered in every large shipping city, and they are bought and sold by dealers in bills of exchange, who are alert and vigilant in watching the fluctuating values of the moneys of different countries. And these dealers in bills of exchange are on the alert, not only to avoid loss, but to obtain profit because of these fluctuations. Their charges for handling bills of exchange between two countries having the gold standard, such as the United States and England, cannot, as a rule, be much greater than the cost of shipment of the actual money, plus the interest for the time it is out of service. But, for the handling of bills of exchange drawn between countries one or both of which may have a fluctuating currency, they charge sufficient to protect themselves from loss by reason of possible or probable fluctuations.

In a previous paragraph it has been pointed out that a country having a fluctuating currency is at a disadvantage in obtaining imports. It can readily be perceived that it is likewise at a disadvantage in disposing of its exports. The prices of all similar products of exporting countries are subject to competition in the countries of import. This fact alone places the merchants of the country having a fluctuating currency under a tremendous disadvantage, as compared with the merchants of countries having a stable currency. But there is the further fact that, largely because of the smaller risk in handling bills of exchange drawn upon countries having a stable standard, such bills are always more readily to be obtained than bills drawn upon countries having a fluctuating standard. Merchants of the latter countries, therefore, often have to pay a heavy premium to obtain bills of exchange at all, their facility for the disposition of their products being often thereby further decreased. It follows, therefore, that, if one standard of value is dominant among the countries most largely engaged in international commerce, any country having a currency based upon a different and fluctuating standard is hampered in its efforts to continue in such commerce. As gold has become the dominant standard of value of the great commercial powers of Great Britain, France, Germany, and the United States, it follows that, should any of these countries—the United States, for example—adopt another standard, it would place its merchants at such a disadvantage that, under the stress of modern competition, the exports of the country would tend to decrease instead of to increase.

As the capacity of the United States for production is at present largely in excess of its capacity for consumption, and as its future prosperity depends largely upon the increase of its exports, it follows that such result would militate decidedly against the interests of the entire nation, and particularly against the interests of those immediately concerned in the erection and maintenance of the structures used directly or indirectly in the production and transportation of such exports. As the value of silver is subject to great fluctuation, the adoption of the silver basis for its currency would bring upon the United States the evils incident to a fluctuating standard. Its import and export trade would be hampered and restricted, and our travellers, who annually visit other countries in greater numbers, would be subject to inconvenience and loss in obtaining money current in those countries. The pound sterling of Great Britain is the most universally recognized unit of value in the world. There is not an important mercantile establishment in the Occident or the Orient that does not know its value at all times. The franc of France and the mark of Germany are likewise of definite and recognized value in all places. This does not hold true of any silver coin issued by any government on earth. Shall the United States strengthen its position among the foremost nations of the world by maintaining the standard of the gold dollar, or shall it abandon its position in the vanguard by adopting a varying dollar of silver?

There seems but one reply possible to this question. That thousands, perhaps millions, of the people now living in our country think that we can achieve prosperity under a monetary system chosen without regard to the international standard of value; nay, more, that by many it should be considered servile for the United States to pay any regard to that standard, and an indication of our glorious independence to ignore it,—seems inexplicable. But the reason for such a feeling can, in part at least, be explained, if it be considered that the industrial development that began on the eastern shores of the great European sea has not proceeded in unbroken cycles, nor, until within recent years, has the true meaning of that development been perceived.

In the dawn of history the contact of tribes was principally that of conflict. The conquering race reduced the vanquished to slavery, and the result of its efforts was obtained by scourge. When the victor could no longer hold the vanquished in the bondsman's leash, he still levied tribute out of all proportion to our modern sense of right. Throughout all history there has been outrageous levy by kings, popes, and emperors, upon the people of other nations. When any group of people has made successful rebellion against such servitude, it has been said to have established its independence, and independence has become the watchword and the cry of patriotism.

In the last century the American colonies won a wonderful fight against their British oppressors, and that superb struggle has been so lauded in our schools and in our prints that to many it seems that independence includes contempt of all the institutions of other lands than our own. Therefore, when it is urged that we cannot prosper under a standard of value different from that of the great European nations, they think an attempt is being made to degrade us to a condition approaching that from which we escaped over one hundred years ago.

All mankind has been slow to learn that civilization depends upon industrial coöperation, and not upon industrial antagonism. International commerce that mingles the products of climes and countries is but the highest expression of that division of labor which began when there was the exchange of baskets and pots between the weavers of bands and the moulders of clay. Through the centuries, as that commerce has increased, there has been emulation between the nations in the adoption of methods that simplify, facilitate, and make less hazardous its processes. The mariner's compass is on every vessel; one maritime code of signals is known to all sailors. Compass and code that guide and guard the vessels laden with products and passengers are, like bills of exchange and the standard of value upon which they are based, but tools that ease the conduct of commerce. No nation can maintain a foremost rank among the commercial nations of the world with an isolated standard, any more than its marine would flourish if it attempted to guide its ships by the stars and to use a code of signals peculiar to itself.

It is often claimed by advocates of the silver standard and by some bimetallists that the countries having a silver standard are at an advantage in exporting their products in competition with other countries, because, as wages are paid in these countries in silver, the cost of production is less than in countries where wages are paid in gold. But it must be reflected that exports to and imports from the great commercial powers are bought and sold upon the gold standard, whatever may be the domestic standard of another country. For example, an English merchant importing wheat from India calculates how many rupees he can buy with a pound, and how much wheat he can buy with these rupees. If wheat from India can be sold in Liverpool at less than wheat from America, regardless of the fluctuations of silver in the English market, the American producer is being worsted in competition with the Indian producer not because of the silver standard in India, but because the absolute advantages of the Indian producer in production and transportation outweigh the disadvantages of the silver standard. The Hindoo works for little, and can purchase but little. India is not, in proportion to its population, a great market for the world's products. A nation is commercially great and is in the highest sense prosperous when its commerce comprises vast quantities of varied merchandise. And this stage is reached only when its members progress to familiarity with and need for articles that the Indian laborers do not know the use of. In the generations to come, when from their present perceptible awakening the Hindoos have reached a higher development, they will not be content with the crude food, clothing, and habitations that now satisfy them. When that time comes, there will be the ebb and flow of commerce, profitable alike to them and to the nations with which they deal, and they will need a more stable and more valuable standard than silver, as surely as the Japanese, whose progress has been so marked, are approaching the standard of gold. Between the Japanese and the west is the Cossack, who has found himself hampered by the silver standard; and further sustaining the immediate argument is the fact that over ninety per cent. of the world's commerce is between the great powers adhering to the gold standard, whose citizens are better housed, better clothed, better fed, and more appreciative of the higher arts than are any of the other races of men.

In conclusion, attention is again directed to the consideration that appeals with overwhelming force to the constituency of this magazine. The development of the resources of a country depends upon the building of railways and bridges, the opening of mines, the erection of mills and elevators. The inception and prosecution of these enterprises are made possible only by the use of enormous capital which flows readily into investments promising sure returns, but shrinks from outlay in directions whence returns are uncertain, as they must be if the currency rises and falls in value. The natural resources of the United States are of unquestioned magnitude and variety, but the accumulated capital of other countries which is needed for their exploitation, and which in times past has come to us liberally, now lies in the vaults of Europe. With every intimation that our currency may drop to the silver basis, that capital is withdrawn by the million. Should the November elections not overwhelmingly and undeniably indicate that the American people pledge themselves to maintain the stable standard of gold, the blight that will come upon our industries will fall with heavy and smiting force upon the engineers, whose welfare almost absolutely depends upon the prosperity of industrial enterprises. These gentlemen, therefore, not only have the general interest of patriotism in exerting every influence to roll back the tide of silver, but the immediate interest that particularly affects themselves and those dependent upon them.

LUXURY AS A STIMULUS TO RAILROAD TRAVEL.

By H. G. Prout.

LAST month we saw that, whereas every inhabitant of the United States took 5½ journeys by rail in 1882, he took 7¼ in 1895,—that is, he travelled 31 per cent. oftener in the latter year. We saw that the total travel was equivalent to one person going 7,688,500,000 miles in 1882 and 12,188,500,000 in 1895. We saw that the average man travelled 146.7 miles in 1882 and 174.1 in 1895. While the population increased about 33 per cent., the total passenger movement, as measured by the passenger-mile unit, increased about 60 per cent. We considered somewhat the influence of fast trains in increasing passenger travel. The obvious growth of comfort, of beauty, and even of luxury in cars and stations suggests that these may be important influences in inducing people to move about by rail.

I remember many railroad journeys which, it seems to me, one could take for the pleasure of the journey, apart from the wish or the need to get somewhere. I remember sitting by the window of a beautifully-appointed dining-car and eating a comfortable dinner while looking out on the noble Hudson; and smoking at ease in a "café-car" while gliding through the Mohawk valley; and lounging in an observation-car up the valley of the Juniata and over the Alleghenies; and winding down the New River valley where more than sixty per cent. of the line is on curves, and where splendid pictures open up in swift and incessant variety. I remember, too, charming journeys when, seated in a beautifully-upholstered, first class compartment, I have seen the English farms and villages and parks and forests slip past. Remembering all this, I am led to think that many a man is tempted to travel merely by the luxury of modern travel.

But what is luxury? The Century Dictionary says that luxury "is that which is delightful to the senses, the feelings, etc., especially that which gratifies a nice and fastidious taste." Webster says that it is "anything which pleases the senses, and is also difficult and costly to obtain." In this light I sometimes doubt if anyone has tried the experiment of making railroad travel luxurious on a sufficient scale or for a long enough time to know much of its effect in increasing travel. There has been a considerable display of that which is costly and difficult to obtain, but less of that which gratifies a nice and fastidious taste. Indeed, a very plain and ordinary taste will still often find more to offend it than to please it in a journey of twenty-four hours on an average sleeping-car. One need not be nice and fastidious to be shocked by the unfitness, tawdriness, and vulgarity of a good deal that he must still see and endure in many a railroad journey. Taste in car-decoration and sense in car-furnishing have grown immensely in the last ten years, and the average "sleeper," built within, say, three years, has been purged of the worst features of its ancestors; but, if less pretentious in appearance, it is still deficient in some of the essentials of actual comfort. Up to within a few years the men who sought to make the sleeping-car attractive to the public by displays of beauty and luxury seem to have been governed a good deal by the standards of the western millionaire who had just built for himself a palace. His wife was shocked by the stains on the new carpet. "Don't mind that," he said; "it is easier for me to buy carpets than to look where I spit." The barbaric desire to show folks how rich you are corrupted the taste of the designer of the car and of its furniture. To him luxury meant that which is costly and difficult to procure, not that which is fit for its uses or pleasing to a nice and fastidious taste. Late designs show a tendency towards simplicity and utility, but the influence of untutored wealth is still predominant. It makes the cars cost too much to build and maintain; it threatens public health by providing lodgment for germs; and it corrupts public taste.

At the Atlanta Exposition the beautiful Pullman train which had been shown at the World's Fair at Chicago was exhibited. My colleagues on the jury of awards wished to give to this a gold medal, an award which I opposed somewhat, but not at all strenuously, for I did not feel sure that I was right. To me that train was a beautiful and indeed a wonderful exhibition of the skill of the architect, the cabinet-maker, the decorator, the upholsterer, and other craftsmen, but as a railroad train it was an absurdity. Its influence was bad, and it deserved rebuke rather than reward. However, perhaps I am a crank. At any rate, the train got the gold medal.

It is reasonable to suppose that handsome surroundings which gratify the eye and soothe the mind, and comforts which rest the body, attract custom to a railroad; that they not only draw passengers from rival roads which offer less that pleases the fastidious appetite and taste, but actually induce people to travel for the pleasure of traveling, or, at least, do not discourage them. It may be interesting to look a little at what the railroads have done and are doing to make travel pleasant.

We may properly begin at the station. In the great cities some splendid edifices have been built in recent years, with vast rooms and a wealth of decoration. The new Union station at St. Louis, for example, has a frontage of 606 feet and an average depth of 80 feet. Two of its floors aggregate 70,000 square feet in area, entirely devoted to the accommodation and comfort of travelers. Each of these has a great hall 76 feet × 120 feet, and the hall on the second floor has a barrel-vaulted ceiling 65 feet high. There are special rooms for women and for men, restaurants, a private dining-room, and all the offices necessary for the administration of the business. The details of finish are beautiful, often sumptuous, and very costly. The new station of the Illinois Central at Chicago has a waiting-room 100 feet × 150 feet and 75 feet high. The great vaulted ceiling, like that of the St. Louis station, is a single arched span without intervening columns. There are other recent notable stations in Chicago, and in the east we find the new Reading station in Philadelphia, the enlarged and improved Pennsylvania station, and the new Union station in Boston. These are a few examples of the most important and costly of recent stations. They illustrate much that is characteristic in the latest station architecture, and they strengthen the opinion that we are passing through a period of profuse expenditure for spectacular effect, and that a truly civilized architecture must give more recognition to the beauty of adaptation. We should expect in the next decade or two to see comfort, convenience, economy, and beauty of proportion, rather than beauty of space and lavish ornament, prevail in the design of stations. The most common defects of the great city stations are the use of the waiting-rooms for other purposes than waiting; too little provision for dealing with crowds at the ticket windows, and cramped passages to the trains. The comfort of those who wait is destroyed by the throng, and the convenience of the far greater number who do not wish to wait is sacrificed by crowding them into large spaces and suddenly disgorging them through narrow doors and gates. The common English practice is simpler, cheaper, and far more comfortable and convenient. You find there ample ticket windows opening on broad passages leading directly to the train shed, and passengers do not need to pass through the waiting-rooms at all. Having secured your ticket, you can go at your leisure and ease direct to your train. If you must wait, you find waiting-rooms, which are small and quiet, being only waiting-rooms and not passage ways or offices or bazaars. If, then, we consider American station architecture as a means of attracting reasonable people to the railroad, it seems to have been developed on the wrong lines.

In other elements of comfort and utility our stations are not notably successful. The restaurants, as compared with those of England and France, are either inferior in elegance and comfort, or they are dear. The toilet and sanitary arrangements, as compared with those of England, are inferior in completeness and cleanliness.

Of country stations little that is good can be said. Around a few of the great cities some charming ones may be found,—pretty buildings with walks and drives and flowers that tempt one to turn aside from the highway, and that may even lead one to think favorably of a railroad journey. But the immense majority of the country stations are grossly utilitarian and without the least hint of nice and fastidious taste ; often they are simply squalid.

But let us pass to the train. Here, at least, we may hope to find comfort, and, in extreme cases, luxury ; and, if we compare the present with the past, we shall not be disappointed. Those who saw the old Camden & Amboy cars of 1831 which the Pennsylvania Railroad took to the World's Fair in 1893 will grant this. The low roofs, the minute windows, the straight, narrow, hard benches would make a journey a penance to be endured if necessary, but never to be undertaken willingly. This car long ago developed into what is now the typical day-coach, providing a reasonable cubic space for each traveler, with large and well-glazed windows, and with clear-story ventilators ; but the seats improved only very slowly. The necessity for reversing kept the back straight and the seat horizontal ; the desire to economize space kept it shallow. In course of time the reclining-chair was developed, and this has become a necessary feature on western railroads ; but the reclining-chair is not economical of space, and a few years ago Mr. Forney undertook to design a seat which should be as comfortable as the reclining-chair and yet fulfill all the requirements of the ordinary day-coach seat. He went at the job in a scientific way, and evolved the Forney seat with its deep cushion, whose forward edge is raised automatically when the back is reversed, and whose high back is designed to fit the human figure. While the use of this seat is by no means universal, it has modified the designs of other makers, and has shown them how to make a comfortable car-seat.

The chances are that we shall find the day-coach more comfortably lighted, heated, and ventilated than the average sleeping-car, and this is especially true in respect of lighting and ventilation. Of the 36,000 passenger-equipment cars of the United States (including baggage, mail, and express) 9,400 are now equipped with the Pintsch system of lighting by compressed oil gas. Some hundreds are fitted for burning compressed city gas, a few with the dry carbureter system of gasoline lighting, and a very few are lighted by electricity. The rest are lighted only by kerosene lamps ; but in the day-coach one can usually read fair print with some comfort, while in the sleeping-car he very often cannot read without abusing his eyes. There are certain special reasons why the sleeping-cars, as a rule, are not so well lighted as the average day-coach. It has been somewhat difficult to extend to them the system of lighting by compressed oil gas, for the reason that any one car must be ready to run over a considerable number of railroads, and gasing plants have not been frequent enough to make it possible to recharge at convenient intervals. This difficulty has now nearly disappeared. The method of lighting by compressed city gas is confined practically to one railroad system, and there are several particulars in which it is inferior to the compressed oil gas system, and for this reason it has not spread to other roads. Lighting by electricity is still a costly luxury for any class of cars. It is used only on a few "limited" trains designed to be especially attractive, except on the Chesapeake & Ohio, where many cars are lighted by electricity from storage-batteries, in ordinary service. Electric lighting must still be regarded as too costly to use, except for advertising purposes. Such, briefly, are the reasons why the average sleeping-car is still very indifferently lighted.

It is not so well ventilated as the average day-coach, because the doors are not so often opened, because the flow of air through the car from the door is obstructed by the special rooms built at either end of the car, and because the vestibules cut off the inflow of fresh air when the doors are open. In other words, the day-coaches get more frequent change of air accidentally,—not because they have any superior system of ventilation. In fact, no system of ventilation by which an ample supply of fresh air shall be provided in any car, regardless of the opening or the closing of the end doors, regardless of the direction and velocity of the wind, and regardless of the speed of the car through space, has yet been developed in any country. In the matter of heating we are better off. The methods now in common use are probably adequate, if used with reasonable care on the part of the trainmen On the whole, the modern day-coach seems to be about as comfortable as it can be made, if it is not crowded.

In the sleeping-car one is sure of more room than in the day-coach, and that is one of the greatest elements of comfort in a railroad journey. The seats are sufficiently well cushioned and are of ample proportions, and of the beds no one need complain. But luxury, and even comfort, break down when one goes to the dressing-room. The most enthusiastic person could hardly claim that he can make his toilet luxuriously on a sleeping-car. To stand in a crowded corner, subject to the observation of passers-by; to wash one's face in a basin which another man has just used for cleaning his teeth; to dry one's self on a scrap of a towel smelling of the laundry,—is a very poor substitute for the comfortable temperature, the brisk shower, and the big, sweet towels which almost any man can have in his own bath-room.

In this brief review of the ordinary conditions of railroad travel we must not neglect the dining-car. With its fresh linen and bright glass, its flowers and copious bill of fare, this institution has a superficial attractiveness, and has done much to divest travel of its terrors. It is an immense advance over the hasty and precarious meal at the wayside eating-station. It has elevated taste, and has helped to improve our national cooking. Within three or four years it has invaded England, and mitigates the longest journeys there, by both first and third classes, —for third-class dining-cars are now run, and give excellent service. But I am disposed to think that the dining-car service is not precisely what it will be a few years hence. The man who knows how to eat much prefers fewer dishes, better cooked ; and we may reasonably expect sometime to be able to order from the card a steak or chop or bird, specially cooked, and to get with it a mealy potato boiled in its jacket, and a mug of ale. Some day we shall be emancipated from the twenty kinds of things with fine names, all tepid and all tasting much alike. In fact, the dining-car, with all its merits, is not the perfect flower of our civilization. It is very costly to operate, and is an incomplete solution of the problem of feeding passengers. There are places in this country where one can get a simple and comfortable meal at a country station, and enjoy the rest and change of stopping to eat. Furthermore, I have yet to hear any sufficient reason why cheap and wholesome basket-lunches should not be put aboard to order, at certain stations, as is so commonly done in England. I wish someone would try the experiment here,—well and on a large scale. Some roads have begun the practice of serving light lunches *à la carte* in the dining-car, and one or two serve all meals this way on certain trains. One road, at least, serves a "train lunch"; that is, one may be served in any car of the train with a lunch from the dining-car.

So far I have written of the average conditions under which the American citizen must travel. There are conditions considerably better calculated to induce him to move about, which may be found on some trains in some regions. For instance, most of that which is least agreeable in the sleeping-car is avoided in the compartment cars now run regularly on a few railroads and a few trains. There one may secure one of the two berths in a compartment, or both of them, at the same price that he must pay in the open car. He has comfortable toilet arrangements in the compartment, with hot and cold water. If he has an electric reading-lamp in his berth, and can go forward to a "café-car" to smoke and drink a cocktail and see his fellow-passengers, he ought to feel pretty well satisfied with what he gets for his money. The observation-car at the rear of the train, with moveable wicker chairs, and the library-car, with writing-desks, papers, magazines, and books, are not very unusual now. More exceptional trains are those which carry a stenographer and type-writer, a lady's maid and a barber, and a bath-room.

All these exceptional conditions, however, are still so unusual that they can have but a moderate effect on the volume of travel and the revenues of the railroads. The great and serious results are produced by the average conditions. These, while hardly coming within the definitions of luxury, are so comfortable that a person of ordinary health and energy, with some enterprise of spirit and a well-developed curiosity, can often find in a railroad journey positive enjoyment. I have endeavored to suggest some particulars in which travel can be made still more enjoyable, and that generally without expense to the railroad companies. Some of the improvements which seem possible would, indeed, diminish first-cost, if not working expenses; for, after all, it is true that that which gratifies a nice and fastidious taste is not usually that which is costly and difficult to obtain.

THE CANTILEVER AS APPLIED TO BUILDING CONSTRUCTION.

By John Beverley Robinson.

IT is commonly said, in reply to demands for the invention of a new style of architecture, that it is impossible that such a thing should be invented; that styles of architecture must develop slowly from present conditions by paths that we can hardly anticipate.

No doubt that this is most true; that, like everything else, architectural style and other styles—of dress, of ornament, of music—must evolve, as modern thought and investigation have settled, from what now is, as what now is has evolved from what was.

Nevertheless, laying aside all dogmatism, placing no undue faith in our own conclusions, it may be of interest to observe as well as we may the tendencies of architectural design at the moment, and to forecast the possibilities at least of the future; as the foot-traveller through mountain-lands strives to forecast the course of the path before him, whether it will wind on this side or on that of the opposite peak, judging from the topography of the country over which he has just passed, and from the black furrows in the wooded hills, and the sharp gaps in the foliage ridge against the sky, that his eye may be able to discern.

And, first, as to what constitutes an architectural style. In popular opinion such is but a certain character of ornament, equally applicable to any building at will. That a building may be Greek, or Moorish, or Gothic, at pleasure, or made over into all by turns, by recarving and repainting,—this is the common view. To some extent, too, this view is justified by the way that even architects have of fitting up rooms in all kinds of styles,—Renaissance, Indian, Japanese, Persian, Pompeian, Flemish, Elizabethan,—giving much ground for the opinion that architectural style is a matter of mere whim.

Partly, too, the nomenclature of the revival of antique culture is responsible for this opinion. We have all been taught to connect the word style with certain conventional schemes of ornament by which ancient designs were crudely catalogued,—Doric, Ionic, and Corinthian,—ignoring the freedom with which the live Greek artist modified and combined them.

In the *Architectural Record* for the third quarter of 1894 an article by Montgomery Schuyler was published, giving illustrations of the great cantilever bridges, and noting the possibility that the cantilever might be used in architecture. I am indebted partly, but not altogether, to that article for the first conception of the idea that I have tried to develop.

TEMPLE OF NEPTUNE AT PAESTUM.
A Type of Greek Lintelled Architecture.

A more judicious use of the word "style," applied to architecture, places fundamentals first, and regards the ornament as growing out of the system of construction employed. In all minor arts, too, the same principle is found.

In costume, for instance, it is interesting to observe how the best designers of women's dress, whatever be the fashion of the moment, start with a logical scheme for the construction of the garment, upon which it is either really or supposably built. Thus a triangular front and collar, of a different color, will perhaps be interpreted as a separate under jacket, and will justify the use of the same material and color for the ostensible under-sleeve. When elaborate draperies of the skirts are worn, the same constructional principle is observed.

So, in architecture, a style is more broadly defined as a coherent system of construction, reasonably and suitably adorned. Specifically, it has been said that the points wherein one system of construction is to be distinguished from another, so as to constitute an architectural style, are two,—the method of roofing areas, and the method of bridging openings. Thus, not to enter into too great detail, the classical styles of antiquity are based upon the lintel, for covering both openings in walls and for roofing areas. In all probability the typical buildings of the Greeks were supposed to be roofed with stone, as well as stone-lintelled at doorways and intercolumniations.

Whatever view we may take of the unexhausted question of the hypæthral temple, there is no doubt that the colonnaded side-aisles, as well as the external colonnades, suggest, by their massive columns and narrow spans, the stone roofs of the Egyptians. And, although the central space was certainly often, indeed usually, roofed, yet the leading idea of all buildings of warm countries is the courtyard, not the roof; the open peristyle for coolness, not the enclosed hall and hearth for warmth.

Even private dwellings were grouped about a central court of some kind, and, although convenience made it necessary to cover the court of the temple, it probably remained—in theory, at least—an open court, while the narrow intervals of the surrounding colonnades permitted flat stone roofs, to match the stone architraves. The ceilings of the colonnades are known to have been of stone, and the timber roof above these is not more anomalous than the same anomaly in Gothic construction.

The next completely-developed system of construction, the medieval Gothic, was based upon a development of stone vaulting for roofing areas, resulting in the familiar pointed arch, as constructively most available; the arches over openings in walls, also arched, in outline correspondingly pointed.

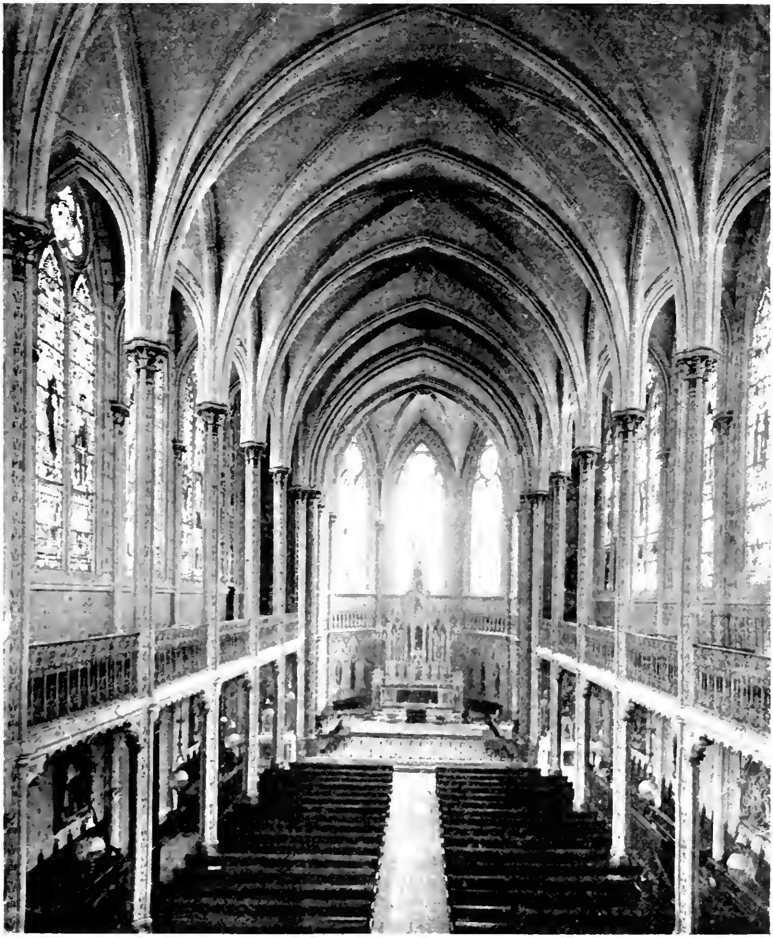
In all other styles arches and lintels have been used, no doubt, as the pointed and horseshoe arches in Moorish work, where arched construction reached a certain stage of very beautiful and logical elaboration; but the Greek and the flower of the Gothic styles have ever been regarded as the most complete working out of their respective principles of construction.

We are to seek, then, not for a new scheme of decoration,—that will come of itself in due course,—we are to look rather for the possibility of a new system of construction, and chiefly as applied to covering in spaces, and to spanning openings in walls.

For these purposes architecture has as yet advanced no new device beyond those known from immemorial ages,—the lintel and the arch. Even in such work as has involved the use of that really new material, iron, architecture has stuck to the old forms. So, too, for the most part, has engineering: yet, in addition, there have been used in engineering work two new principles, both exceedingly well adapted to iron as a material, and one of them, I think, architecturally available.

One of these is the suspension principle, the other the cantilever,—both tolerably familiar to everybody.

Of the suspension principle I shall not now speak, although it is not at all impossible that it might be used for covering vast areas. I can easily imagine an international exhibition hall of unheard-of magni-

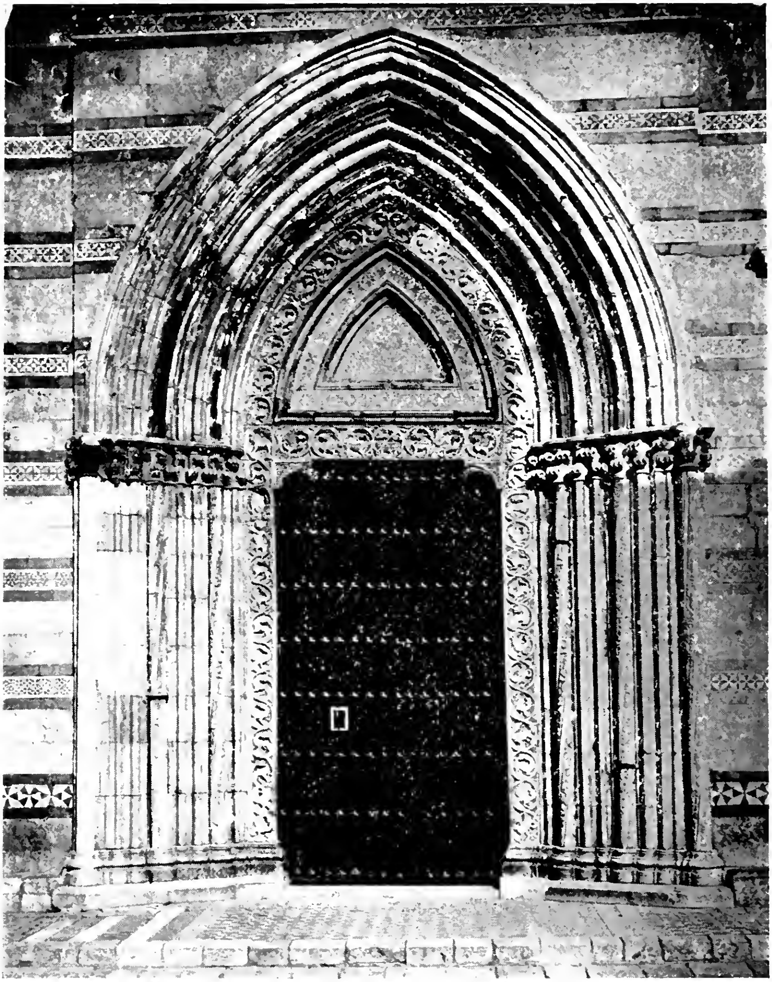


CHAPELLE DES FRÈRES AT RHEIMS.

A Typical Gothic Vault.

tude, perhaps a thousand feet in span, of which the roof might be suspended, as is a suspension-bridge. Still, except for very unusual occasions, the suspension principle is hardly practicable ; nor in any case does it seem to offer any corresponding facility in bridging openings in walls that we have postulated as one of the requirements of a construction that can aspire to be the basis of a style.

The cantilever principle, on the other hand, does, I think, fulfil both the requirements. It is capable of satisfactorily covering areas, and also of bridging openings, while, as distinct essentially from both



DOOR OF CATHEDRAL AT MESSINA.
A Typical Gothic Arched Opening.

the lintel and the arch, it is, I believe, sufficient to eventually give birth to a new and coherent use of harmonious ornament.

The principle of the cantilever, to put it paradoxically, is that you can double the strength of a beam by cutting it in two.

In Fig. 1, for instance, we see a beam, say, twenty feet long, capable of sustaining, say, ten thousand pounds. If, now, the beam be sawed in two, at A and B, the middle piece, being only half the length of the whole beam, will sustain twice the load,—in this case, twenty thousand pounds. The end pieces also are each capable of sustaining ten thousand, each its share of the load of the middle piece. True, they could not for a moment stand, as they are shown in Fig. 1; they

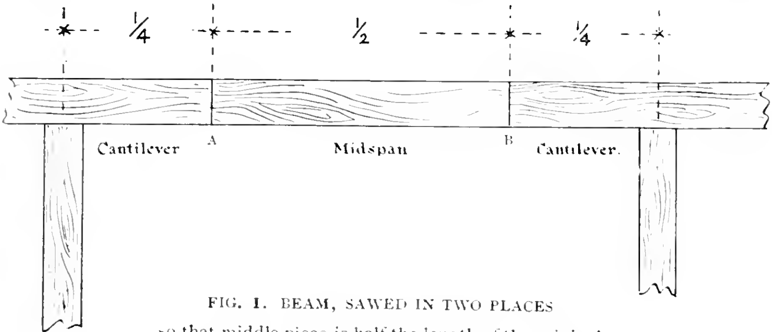


FIG. 1. BEAM, SAWED IN TWO PLACES
so that middle piece is half the length of the original.

must extend over the supporting post, and be held down at the outer extremity by another load, or some other device, as in Fig. 2, or they must be braced by diagonal bracket-pieces. The former arrangement

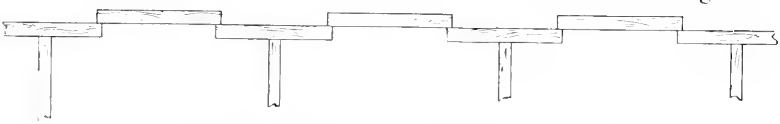


FIG. 2. SUCCESSION OF BEAMS SAWED INTO HALF LENGTHS.
The upper pieces shown a little longer, so as to rest upon the lower pieces which form the cantilevers.

approaches the condition of a continuous girder, and usually needs the addition of bracket-braces, not to add strength, but to provide for irregularity of loading.

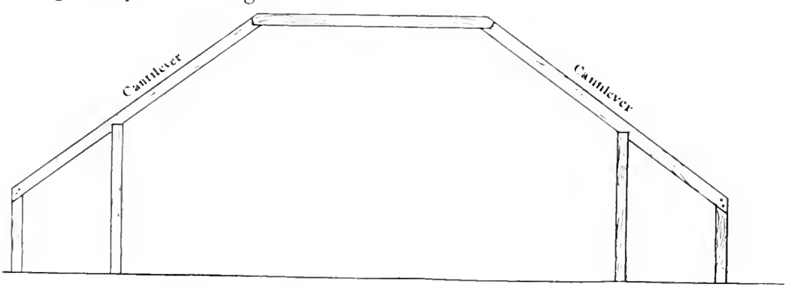


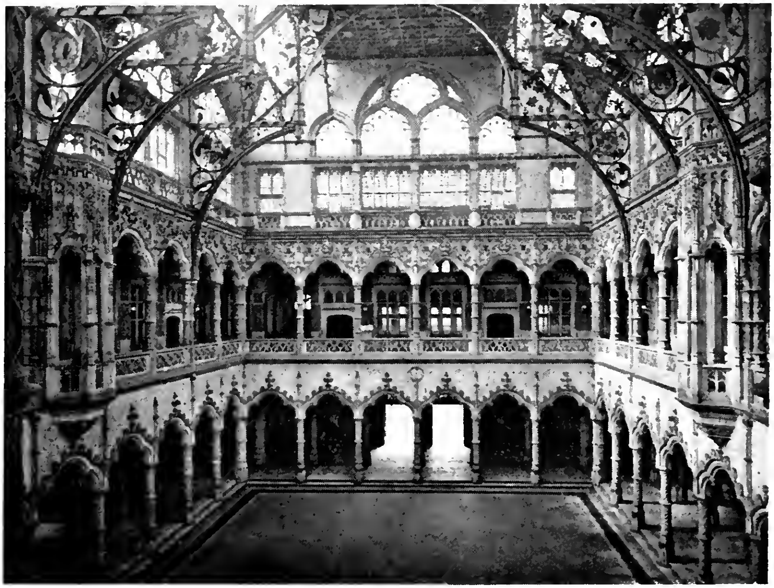
FIG. 3. DIAGRAM SHOWING THE PRINCIPLE OF CANTILEVER ROOF-TRUSS.
As long as the bearings are level, there is no horizontal thrust.

Now, this cantilever principle is very flexible, and may be adapted to many different situations, and to each in varying forms.

In the first place, we may arrange the abutment pieces on a slope, as in Fig. 3, and, as long as we hold the ends firmly down, we have a support for an open roof, without tie-rod, and without thrust; surmounting at a leap the chief obstacle to the employment of iron roofs on a large scale, where appearance is of moment.

And, as in all true architecture, we have sacrificed nothing constructively for the sake of looks, but at one blow have improved both the construction and the appearance.

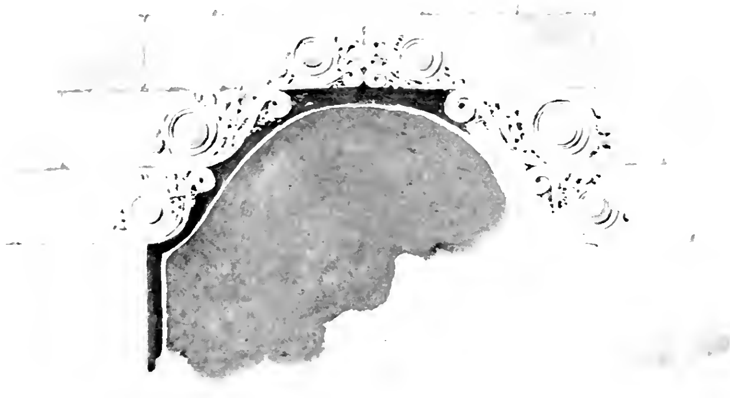
The only condition that attaches to this construction is that there shall be some part of the building, outside the principal span, where the outer ends of the cantilevers may project, and be suitably held down. For many buildings an outer aisle of this kind is natural and reasonable enough. Almost all theatres, music halls, churches, and



THE BOURSE AT ANTWERP.
Good Decoration of Iron Construction.

similar buildings for audiences require galleries for seating. Chautauqua assemblies and summer-school halls require adjacent classrooms, which may conveniently flank the larger hall. Large exhibition buildings—for political conventions, shows of various kinds, athletic contests, fairs, or expositions—naturally adapt themselves to these interior aisles. Or, where interior aisles are unsuitable, exterior arcades, or flanking rows of subordinate rooms, may often be introduced, giving an opportunity for the use of cantilever construction.

Of course the simple diagrams hitherto shown are not the forms in which the cantilever is usually available. Some form of truss, both for



DESIGN FOR CARVED CANTILEVER WINDOW OR DOOR-HEAD.

the cantilevers and for the connecting piece, must be adopted. A simple trussed cantilever roof for timber construction is shown in Fig. 4. In this the cantilevers may be erected in separate pieces and connected by suitable longitudinal bracing: the trusses of the middle span may then be lifted in one piece, after framing on the ground. In fact, it is one of the great advantages of the cantilever system that it dispenses, to a great extent, with the scaffolding and false works that the ordinary truss must have.

In Fig. 5 is shown a suggestion for an iron cantilever roof suitable for a large hall with rooms on each side, either in one tier or in two. In the drawing the second tier of openings is shown as windows, but it

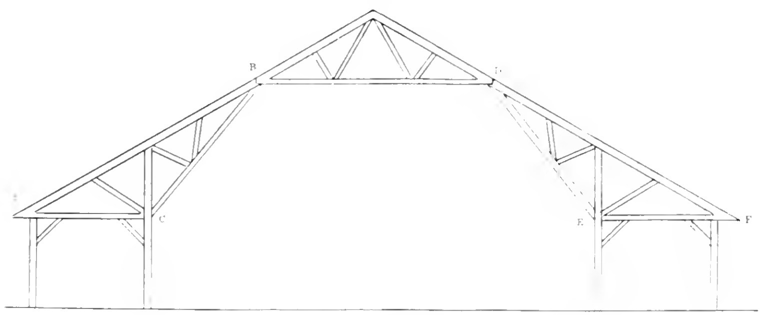


FIG. 4. SIMPLE WOODEN CANTILEVER TRUSS.
The framed triangles, ABC, DEF, are the cantilevers.

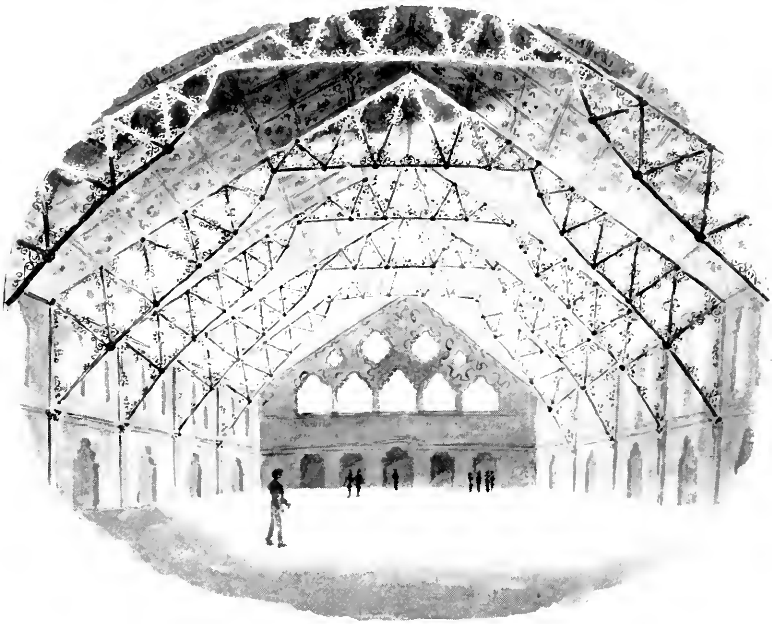


FIG. 5. DESIGN FOR LARGE HALL

with cantilever truss roof, and flanked by smaller rooms. Suitable for an armory, railroad station, etc.

might as well be used for a second story of rooms, and the large hall lighted from the ends and roof. The outer ends of the cantilevers of course are not seen ; they are supposed to be in the partitions between the flanking rooms.

Such a hall might be used for a railroad station, or for an armory ; while, instead of flanking rooms, either internal or external corridors or colonnades may be substituted, producing endless possibilities in adapting the principle.

One peculiarity of a cantilever roof is that there is no pressure on the outer line of supports, if we may call those supports that hold down, instead of holding up. These become really ties, and the foundation must be arranged to bear a pull-up rather than a push-down.

Besides its flexibility in covering wide spans, the cantilever principle has been used to some extent for ordinary floors.

There is a system of fireproof floors that is really a cantilever system. Being a patented device, it will probably not come into general use, but it shows the practicability of the cantilever principle for the most various situations.

One thing, it will be observed, I assume,—that iron is to be the material of the future for floors and roofs. That an ordinary iron truss is about as ugly a thing as can be imagined perhaps all will admit. I am not sure, though, that this ugliness is a necessary quality of iron work. Certainly, where delicacy—at least comparative delicacy—of parts is an essential characteristic, and where geometrical figures govern the proportions, ugliness ought not to result ; a spider-web is a type that is far from ugly ; rather is it the very embodiment of the ideal, a swing for Ariel himself.

It is possible that the future may find methods of detailing truss-work that will display its natural esthetic advantages better than they are displayed by most of the iron work that is done.

In estimating the beauty of ironwork it must be remembered that anything like reasonable ornament for it is seldom attempted. It is not fair to abuse iron as esthetically wanting, as long as we use it only in its baldest and crudest shape. If we take a plain brick wall twelve inches thick and five feet high, we shall find it as deficient in beauty as any iron frame can be.

No more does a plain concrete dome display the glories of a Pantheon. Ribs, or panelling, or at least a color treatment of the smooth hollow, is needed to make it beautiful.

The proper adornment of iron truss-work is of the same nature as that used in iron work on a small scale,—delicate iron scrolls, attached to the main trunks, and saying in their own graceful way to all beholders that their material is strong and ductile, powerful to suspend as well as to sustain.

Something like this has been attempted in the truss shown in Fig. 5.

When iron comes to be regarded as a legitimate material for artistic treatment,—a position which it is slowly approaching, though it has not yet reached it,—new methods of construction perhaps will be discovered, lending themselves more naturally to architectural treatment. It is possible, for instance, that the principle of the tube may be susceptible of development to an extent now unsuspected. Why should not the cantilever trusses of the future, or indeed the various other trusses of the present, be constructed of tubes ?

Both for ties and struts the tube is as available as the rod and the rolled shape. When used for ties, the additional diameter may remedy the appearance of excessive flimsiness ; and, when used for struts, the shapeliness of the tube would happily replace the awkwardness of Z's, channels, and angles.

To form some notion of the advantage of the tube, both constructively and in appearance, imagine the difficulty there would be in building a bicycle of angle-irons instead of tubes, and the very unattractive appearance of the result; whereas the bicycle built of tubes—a manifestly suitable material—is at least as beautiful as any other wheeled vehicle.

It is hardly worth while in an article meant to be merely a suggestive and interesting speculation to enter into any precise statements of the greater strength of tubes compared with other sections.

One point may be remarked, however,—that the tube is of especial value in such designs as require the members to be reciprocally available as either ties or struts. Architectural trusses most of all require this adaptability, as they are subjected more than others to irregular longitudinal strains, especially from wind-pressure. Further, it may be noted in reference to tube trusses, that the jointing naturally develops into a system, jointing now being notably unsystematic. With tubes a screw joint becomes the natural joint for all situations, with suitable rings, spheres, or such, at the connecting points.

Conceive, for a moment, a truss thus built, of tubes perhaps from three to six inches in diameter, with pronounced bosses at all the intersections, forming admirable motives for decoration, and consider whether it might not rescue iron work from its neglected position in architectural design.

Filled internally with some rust-preventing packing,—sawdust and asphaltum perhaps, or something of the sort,—such a truss could be easily protected on the outside, and made sufficiently enduring for its purpose,—as much so as the ancient oaken roofs that we admire.

Truss-building with such materials would become pipe-fitting on a large scale, and, with appropriate appliances, would permit the building of a truss on the spot, as a carpentry frame is now built, the tubes being shipped to the job in stock lengths, cut off, threaded, and screwed together.

Another use of filling may be found in adapting iron supports to proper architectural treatment. The ordinary rolled-iron column, with its rivetted ridges, is scarcely a beautiful object. But, if steel pipes of large diameter, say from ten to twenty inches, should become easily obtainable, their appearance would be pleasing, and their strength could be much increased by a solid filling of concrete, asphaltic or otherwise in composition. The strength of a compound column such as this is hardly calculable, but would have to be determined by experiment; it might be regarded either as a concrete column, restrained from bursting by a continuous skin of iron, or as a shell of iron braced throughout its height, prevented from collapsing by the solid filling.

These hints are thrown out merely to reconcile the mind as to the architectural possibilities of iron, and not with immediate reference to the cantilever as the basis of a future style.

As to this, we have spoken at length of the cantilever, whether of iron or of wood, as used for roofing areas; it remains to speak of the principle as adaptable to bridging openings.

We may assume that stone and brick will remain the customary materials for the enclosing walls, whatever be the material of the roofing.

Interpreted in stone, the cantilever becomes the bracket, or corbel, much used in the past, but never a preponderating motive of design.

It is, nevertheless, I think, well suited to become such a motive. Fragile as stone is when subjected to a cross-strain, this fragility has proved no bar to its use in the lintelled styles. When used as a bracket, or more properly as a cantilever,—for the simple projecting beam was first called a cantilever and exhibits the true cantilever principle,—stone is at least as appropriately employed as for a lintel, and the more so as, by diminishing the leverage of the cantilever, we in-

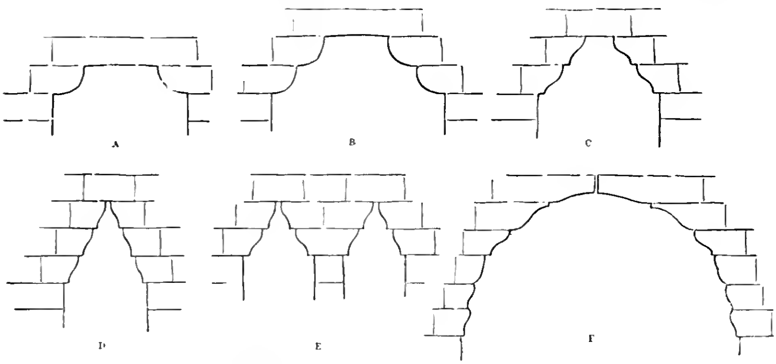


FIG. 6. VARIOUS FORMS OF CANTILEVERS AS USED TO SPACE OPENINGS.

definitely add to the serviceability of the stone. One point must be borne in mind,—that, although stone lintels often break, they seldom fall immediately. The compressive strength of the upper part at once comes into play when breakage has happened, and is usually enough to sustain the lintel,—at any rate, for a while. But, in the case of a cantilever of stone, the projecting end, if broken, drops at once. Consequently we cannot risk even half the projection for a stone cantilever of given depth that a mere calculation of its comparative strength would permit.

Laying aside all idea of decoration for the moment, consider the variety of forms this cantilever construction will permit in bridging openings, of which a few of the scores that are possible are shown in Fig. 6. In that figure A shows the simplest use of the stone cantilever, shortening the span and at the same time softening the angle of the opening, which is the harshest point in lintelled design. B and C show a double cantilever on each side. The principle is as available for tall and narrow openings, as seen at D; while at E a coupled opening at once brings to mind the possibilities of the development of that desideratum in architecture, the bracket capital.

On a larger scale and for greater spans the same motive may be elaborated in various ways, as at F, which falls upon the outline of a full-centered arch. When arched openings on a curved plan are required, this is clearly the logical system of construction.

All of these, it must be remembered, are of the crudest and most off-hand description, the profiles being unstudied and only such as first occurred to the mind.

Even so, some of the arrangements are graceful enough as they stand, and all are evidently capable of graceful development with due study.

With much diffidence I advance a design for an enriched window-head on this principle—in Fig. 7. No one is better aware than I am of the defects in it, or more alive to the truth that a correct treatment of such a feature can be worked out only as a part of a whole. Nevertheless, I throw it out as part of a whole as yet existent only in my mind.

For brickwork the bracketed treatment is especially well suited, the ordinary corbelling, hitherto used timidly and in hidden places, being easily adapted to visible adornment. The stepped diagonal lines harmonize well with the corresponding lines upon which relief diaper and other ornament naturally works in brick, and the steps themselves, inevitably somewhat rough, suit well with the slightly-projecting courses in which the best handling of brick is done.

There is a noteworthy consideration, from a philosophical point of view, in this matter,—that the principles of classical and Gothic design are for the first time united. The genius of the Greek was to refine and adorn the solids, and let the openings take care of themselves; the column, not the intercolumniation, was his care. But with the medieval it was the form of the opening that ruled; the outline of the space enclosed by the arch, whether of aisle or window, rather than that of pier or column.

With the cantilever, both the outline of the opening and the profile of the cantilever itself present themselves as necessary considerations; either one done awkwardly detracts from the result.

THE USE OF ELECTRIC POWER IN SMALL UNITS.

By William Elmer, Jr.

ONE of the most promising fields for the electric motor is to be found in those places where it may be used in small units, particularly in mills and factories. The difficulties in the way, however, have, up to the present time, somewhat limited this use of motors. These difficulties are various, among them the conservatism of past practice being not the least. Power-buildings in cities, for instance, are almost universally laid out on the old and well-established lines of a Corliss engine and boiler plant located in the basement, transmitting power to the various floors by belting. On each floor long lines of shafting are carried throughout the length of the building, and all machines must be so arranged as to conform to this system. The details of light and the safety of operatives are sacrificed to the rigid requirements of a line of shafting. These requirements are particularly inconvenient and distasteful in buildings of the class just mentioned, on account of the diversity of the businesses and occupations carried on under one roof. One man may want his machinery arranged in a widely-different manner from that in which the machinery of his neighbor on the next floor is arranged ; yet all have to submit to the provisions as they find them.

How much more advantageous to the customer would it be if he were allowed, for his own convenience, perfect freedom in the location of his machinery and appliances ! This end could be attained by the use of small electric motors. If the customer's tools and machines were of such a character that they could best be operated in groups on a short section of countershaft, that would be the arrangement he would be likely to adopt. If they were of such a character and so conditioned by the exigencies of service that they required their own motor, they could be set up in the most convenient locations and be supplied from the power-wires in large or small quantities. The ease of control of these separate outfits, together with the independence of line-shaft speeds and directions of rotation, constitutes decided advantages to the users of small powers. In addition to this, it may be noted that any single industry might run over-time without the expense of keeping long lines of shafting in useless motion. Any tool or machine can be easily and quickly changed to a new location, and power supplied to it in the simplest manner.

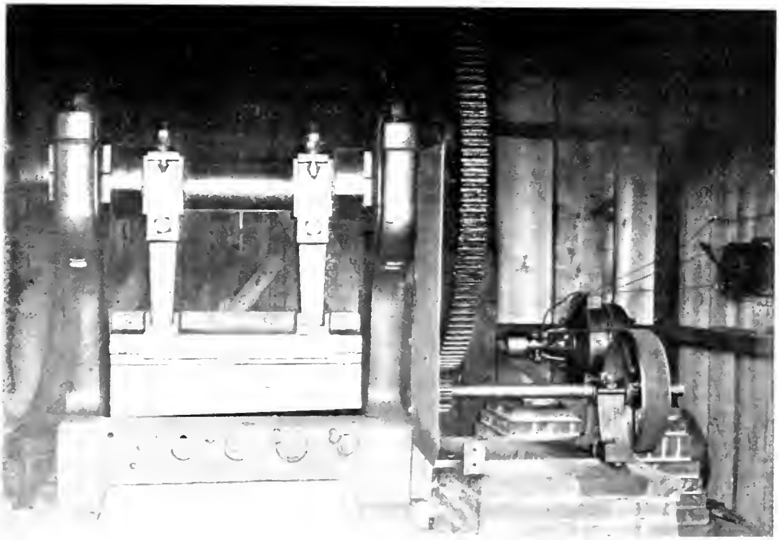
So much for the consumer. How about the producers,— the owners of the building, for instance? As much can be stated on their behalf. If the matter comes down to dollars and cents, as in the end it does, it can easily be shown that they save money in the electrical system. If to the useful power produced is added the friction load of long lines of heavy shafting, the value of the coal consumed, plus the interest, depreciation, and other charges, will amount to more than the electrical transmission would cost, for with the latter there is no waste save the friction of the generators and the electrical transmission and transformation losses. Even with these combined, electrical transmission can always equal shaft transmission in efficiency, and, when the shafting is only partly loaded, the showing is much better for the electrical method. But, even if the actual cost of the latter system were greater than the other, it would be to the advantage of the owners to furnish power by this means. The building would be in greater demand by a better class of tenants, to the mutual benefit of all concerned.

Many of the power-buildings to be erected in the near future will be planned on the lines here sketched, and it is not too much to expect that some of those already employing shaft-and-belt transmission will be converted at an early date. Perhaps under more propitious circumstances this would have been done in many cases already, but the financial conditions of the last three years have absolutely precluded improvements not imperatively necessary. No sane man in these times is spending money for things not needed, and, so long as the power-transmissions already in use are doing their duty, it is idle to expect large investments to be made for new methods. But, with restored confidence and a liberation of capital, such changes will surely take place.

Another class of buildings in which we shall some day see a large employment of electric motors in small units is that constituted by the ordinary shops of industrial establishments. The machine shops and carpenter shops, as well as the various departments of many specialized industries, will be large employers of individual motors. It is not, of course, laid down as a law that each machine should have its own motor. This would, at present at any rate, be distinctly bad practice, necessitating, in some instances, the tying-up of large amounts of capital in numerous small motors, without compensating advantages. But the fact remains evident that in a great many cases the advantage lies decidedly on the side of the direct-connected individual motor. Taking the price of power and the cost of transmission as they stand to-day, the electric motor can compete on an even footing. And when to this fact are added the advantages of no belts to be relaced and renewed, no shafting to be oiled and lined, no restrictions as to the location of machines, and an absolutely clear head room for both traveling and stationary cranes, it may well be asked why the individual motor is the exception and not the rule. Why do not shops all over the country enter their orders for dozens of one-, three-, and five-horse-power motors? If this is all so, why does not the careful manager, mindful of the best interests of his concern, hasten to replace his obsolete methods by more modern ones? The answer is: simply because he is a careful manager. As was said before, the reason can probably be found, in a large majority of instances, in the fact of the recent and lasting business depression. He cannot afford to swamp his concern by the immediate application of large amounts of capital. The problem which at present confronts us is not how much money we can make, but how little we can lose. Very few businesses have been making money lately, and to this fact alone can fairly be attributed the delay in changing to direct driving methods. The old and established shops, as a matter of course, in view of what has been shown, are not expected to change their methods of driving all at once, but it is encouraging, and one of the signs of the times, to find here and there a new plant being equipped with individual motors, or a group-driving system. And this method is not limited to one class of industries. From a machine shop to a cotton mill, through a considerable range of varied manufactures, this system can be seen to-day. It is liked, and it is spreading, and, along with the other improvements coincident with the revival of business, will be found the individual motor.

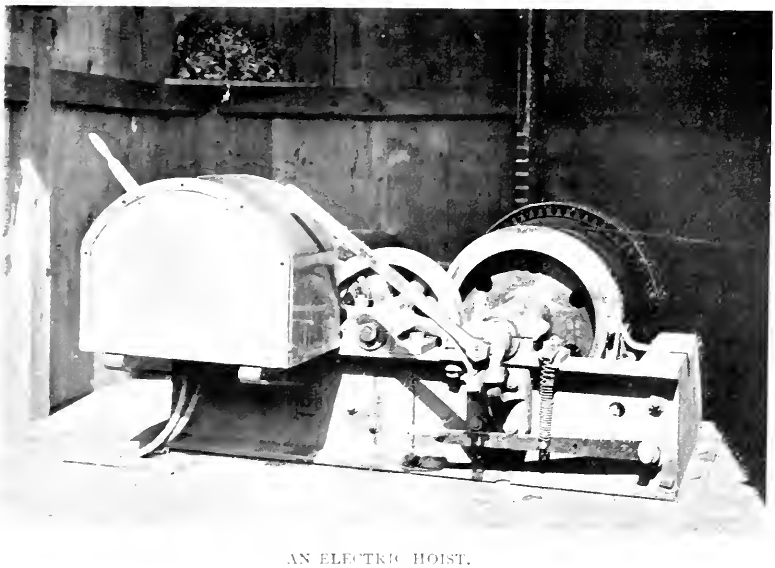
It may be interesting to note some instances occurring in the writer's practice in which the solutions of the problems presented indicate the process of evolution, inevitably pointing the way to the future state of the art. An average case, and one which perhaps will serve as well as any to illustrate the point, is the following: A large shear, used for cutting up scrap-wire in heavy sizes, was operated in a small building of its own, at a considerable distance from the boiler plant of the mill. Steam was taken by a long line of piping to the engine which ran the shear, this engine being built directly on the frame and coupled direct to the crank shaft. Somehow, early one Monday morning, the throttle valve of the engine was opened slightly, perhaps to drain the pipes of the condensed water. At any rate, when the steam came on, off the engine started, and, with no attendant near it, constantly accelerated speed, until it wrecked itself. It was found a mass of broken and twisted parts at seven o'clock. The question then arose as to whether to rebuild the engine or substitute an electric motor; the mill in question had its own electric-lighting and power plant, together with an electric railway for the convenient handling of coal and material in process of manufacture; as the wires were near at hand and a suitable motor lay in the storeroom, the most obvious solution was the application of the latter. When to these advantages were also added the further ones that such accidents would be impossible in the future, and that the condensation of steam constantly going on in a long line of piping would be stopped, the choice was made at once in favor of the motor. The crank disc was taken off the shear shaft, and a large gear was keyed in its place. The motor, supported on a bracket bolted to the frame, had a pinion on its armature shaft arranged to mesh into this gear, and, after the proper connections were made with the service-wires, all was ready for the test. The motor was started slowly, the shear came up to speed easily, and everything worked smoothly until the first cut was made. As soon as the blade came down on the hard steel, the whole frame jarred, so that the carbon brushes jumped clear from the commutator, making a bad flash. All adjustments failed to correct the difficulty; building a pier under the motor did not help matters much, and the individual motor seemed to be a failure. The termination of the trouble was, of course, reached in providing the motor with a foundation of its own and belting to a short shaft carrying a pinion which engaged with the large gear. No jar was transmitted by the belt, and the motor now runs as smoothly as possible. This difficulty will have to be faced in the construction of direct-connected machine tools, which are subjected to shocks and jars, and should be met by making all the parts heavy and solid, and by providing the machine with a good foundation. Then there will be no more trouble in running a shear or press than in running a lathe.

Another case in which the substitution of electricity for steam was decided upon also involved peculiar difficulties of its own. This was a dock hoist used for unloading boats, and was operated by an ordinary semi-portable hoisting engine. After many breakdowns and repairs, it was finally decided to build an electric hoist. This work was done in the machine shops of the company, and a very compact and efficient machine was produced. Then came the question of control; the hoist would be subjected to all sorts of ill treatment, and would sometimes be run by the ordinary Hungarian yard-laborer, and by others who knew nothing of electricity and the handling of electric motors. It was therefore decided to arrange something which would effectually prevent ignorant and careless treatment of the motor and rheostat from resulting in harm to either. A form of construction as simple as possible was chosen, bearing a good deal of resemblance to the ordinary lever operating the clutch of the friction-drum; that was



ELECTRIC MOTOR OPERATING SHEAR.

simplicity itself, being merely a bar a couple of feet long operating in a vertical plane through an arc of about 60°. The controller was arranged with such a lever, thus necessitating a comparatively small num-

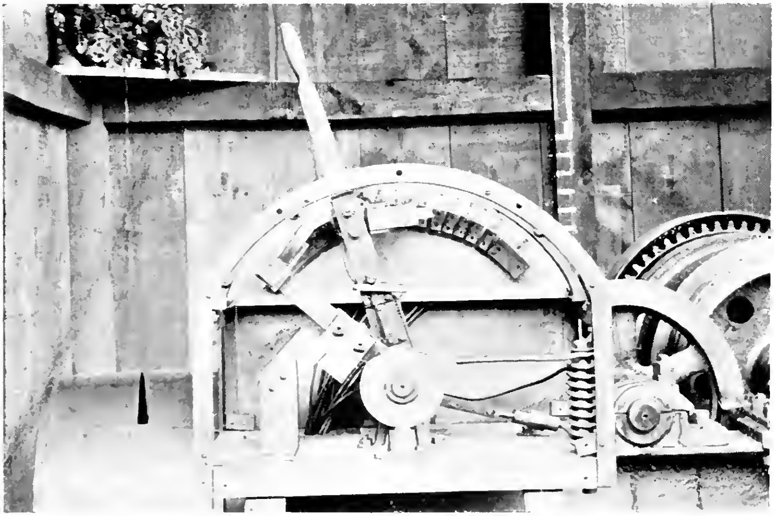


AN ELECTRIC HOIST.

ber of contacts, in order to get them in the space swept over by the contact-brush. This implied a considerable difference of potential between adjacent notches, and would probably have led to destructive arcing and burning up of the contacts very rapidly in stepping back a notch. The next step was to arrange a device to prevent this dropping-back. Another and shorter lever was pivoted to the same shaft as the main lever, and was arranged to sweep over a continuous solid segment throughout its path, except near the end, where it slid off the brass on to an insulating block of the same height and about three inches long. The idea was to release this lever as soon as a backward movement of the handle was made,* and have all the break made at once in a place where a renewable tip was all that would be necessary to take up wear.

A heavy spring supplied the motive power for this quick return lever, and a latching device was applied, which carried forward both levers together. As soon as the main lever was moved slightly backward, however, a roller sliding up an incline plane on a yoke forging drew the latch up with it and released the cut-off lever. This quickly flew back before the main lever could be moved far, and cut off all current from the segments, thus entirely preventing arcing on their edges. The only remaining thing to be done was to provide a small cylinder and piston to act as a dash pot, and insure a proper slowness in throwing over the main lever. It was also decided to make the resistance-coils of such material and size that the motor could run indefinitely on any notch without undue heating. They consisted of coils wound on asbestos-covered iron cylinders, provided with end plates sufficiently large to keep a cover of wire netting clear of contact. These separate boxes, several in number, are stowed away inside the frame of the hoist, where they are out of the way and are always kept cool by the free access of air through the netting. By this brief outline of the construction it will be seen what difficulties are avoided and what advantages secured. Any one who could run the engine hoist can run this without special instruction. He cannot hurt the motor by putting on the load too fast; he cannot hurt the resistance by standing on any one segment too long: and he cannot hurt the segments by coming back slowly or dropping back a notch or two. The principal difficulty in devising this mechanism was found in trying to provide a simple and reliable means of performing the unlatching of the quick-return lever. This was effected by constructing a yoke embracing the main lever, giving the latter a movement of about half an inch before

* This device was original with the writer, who was not aware of the experiments which were being conducted, probably simultaneously, by the Walker Co. The first intimation he had of other work being done in this line was the appearance of their advertisements in June, long after the completed controller had given eminent satisfaction.



CONTROLLER FOR ELECTRIC HOIST.

striking the yoke and carrying it along. A friction disc was provided to retard the motion of the yoke, and this holds the latter still on the return movement, while the roller runs up the incline and withdraws the latch, thus releasing the short lever. On the forward motion the latch is down, engages with the quick-return lever, and carries it along. The operation of this controller can be as well indicated by the description published by the Walker Company as if it had been written especially for it. "The mechanism of the breaking switch is so arranged that, with a movement of the controlling handle backward, the circuit is completely opened by means of this switch, leaving the [contacts] entirely dead. The circuit cannot be again closed until the controlling handle has been brought back to the 'off' position. After the circuit has been once opened by this slight backward movement of the handle, the controlling [lever] can be moved backward and forward into any position, without producing any effect, and it is absolutely necessary to go back to the 'off' position before the switch can be again closed. This feature of the controller makes it impossible to drop back from one notch to another in such a way as to put in or take out resistances in the circuit. This is a point that has always heretofore been carefully covered in the instructions to [operators], but at the same time it has been found that such instructions are often disregarded, it being much easier in many cases, if a decreased speed is wanted, to drop back one or two notches, as the case may be, instead of first cutting off the current completely. There is another point of considerable advantage in the quickness with which the circuit can be opened.'' The similarity of aim in these two controllers is somewhat remarkable, and it is to be hoped that the diverse means taken to accomplish the same effect may prove equally appropriate.

One of the first questions that arises in the application of electric motors is that regarding the amount of power needed. How large a motor should be used? This question is directly answered by a dynamometer, in which a nest of bevel gears transmits power from the driven pulley to the driving one, and at the same time applies torque to the balance arm. This is steadied by a dash pot, and weights are added until the beam remains horizontal. A bell on the machine strikes at every hundredth revolution, so that all the operator has to do is to note the number of seconds between strokes of the bell, and count up the weights; dividing the latter by the former, and this quotient by 550, gives the horse power. In order to shorten even this simple operation, a table has been prepared, showing graphically the

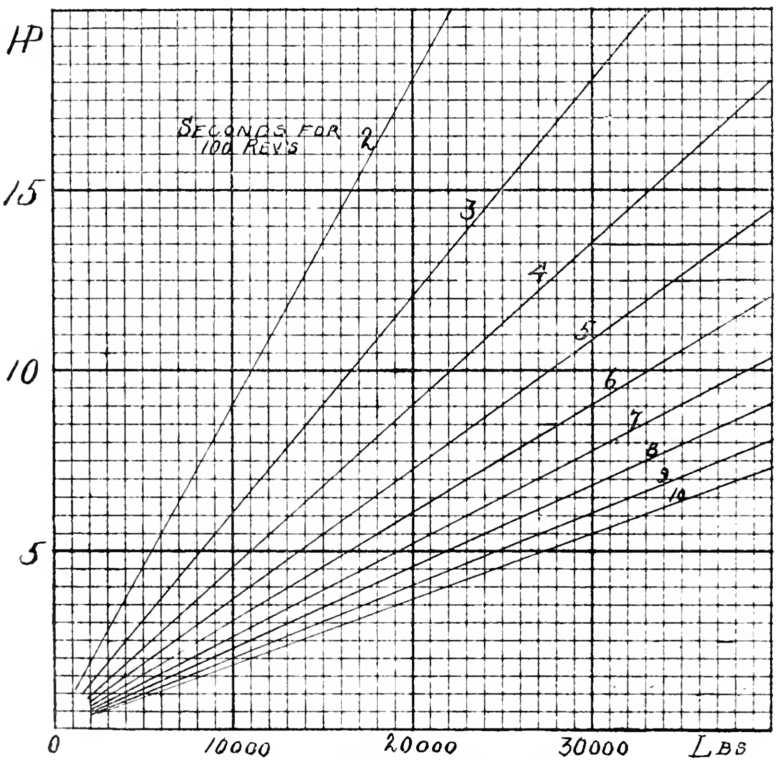
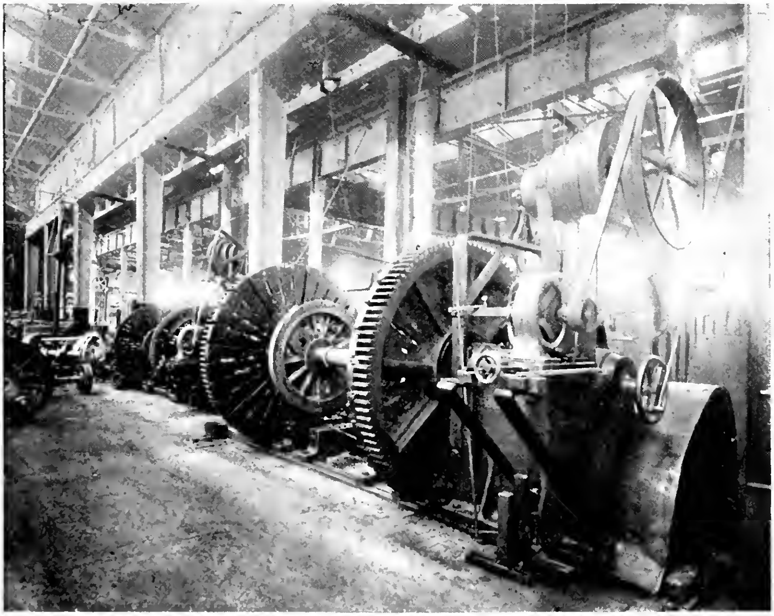


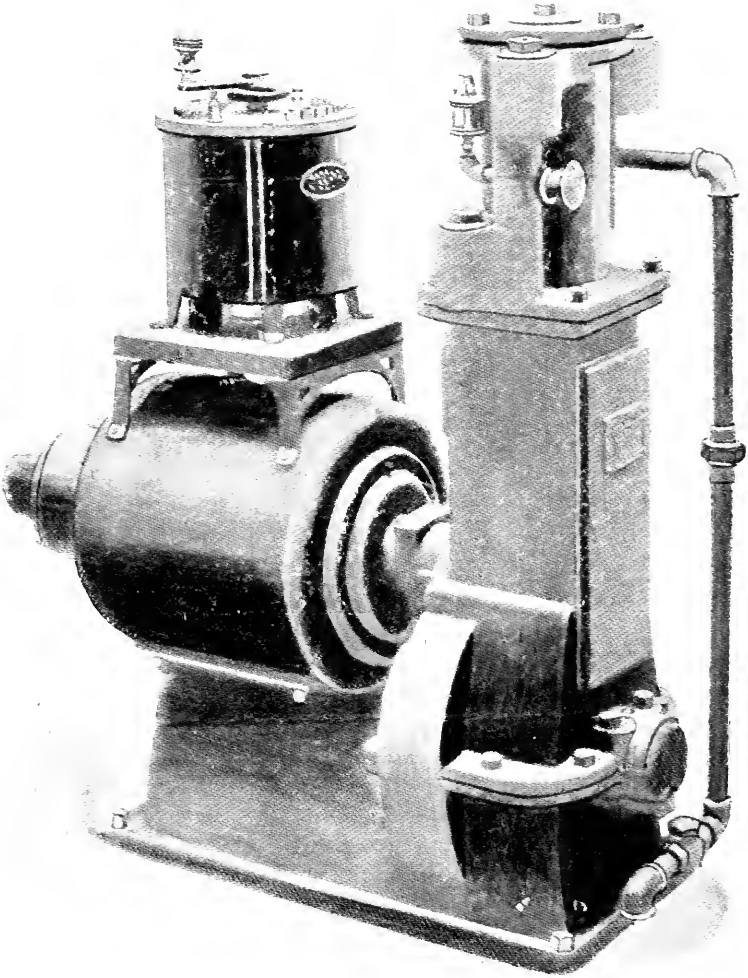
TABLE OF DYNAMOMETER HORSE POWERS.



LARGE LATHE WITH DIRECT-CONNECTED MOTOR.

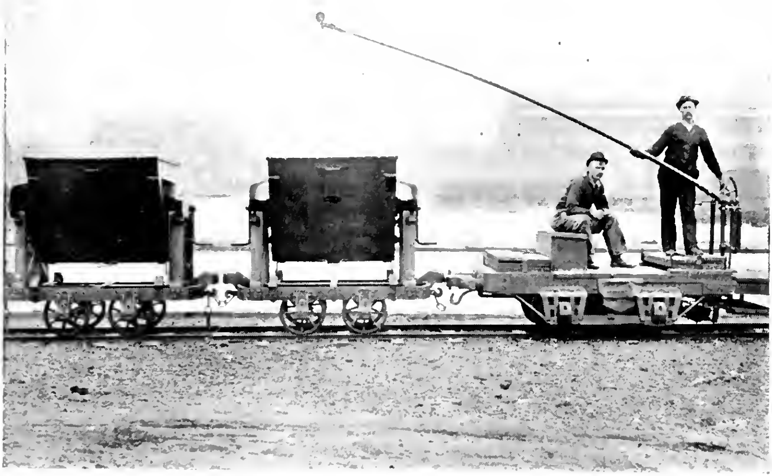
power absorbed at any number of seconds for 100 revolutions, and with any weights. Suppose 7 seconds elapse between strokes of the bell, and the weights count up to 16,500 pounds; the 7-second diagonal is followed out until the intersection of the 16,500-pound ordinate is reached, when, by following back the horizontal line to the vertical axis, the horse power is read direct. This dynamometer can be placed between the line shaft and any tool or machine with the greatest ease. The belt is taken off and hung up, and a short piece of experimental belting run from the driving pulley to the upper pulley of the dynamometer. The lower pulley is then connected to the driven machine by another belt, and the direction of rotation, as well as the speed, is preserved. Fast and loose pulleys enable the whole operation to be completed in a very short time. The horse power being determined, the size of the motor is fixed, and it remains only to show by what means these motors should be supplied with power.

Of the several systems in use at the present time, the ordinary direct-current shunt-wound motor has by far the widest application. Without making any comparisons, which are invidious, an ideal scheme is here sketched out, which could be applied to a large number of mills and factories as at present arranged. In the first place,

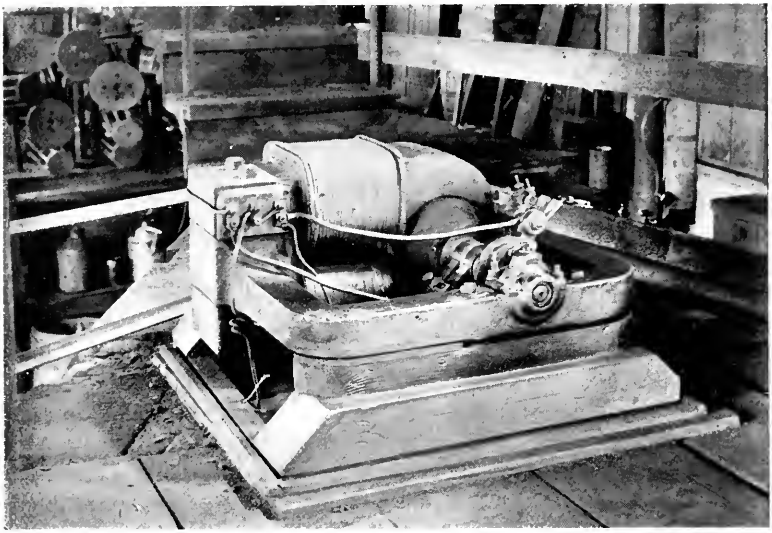


A DIRECT-CONNECTED AIR-COMPRESSOR.

nearly all modern manufacturing establishments are equipped with their own electric-light plants. These are sometimes supplemented with an electric-power plant, but it is safe to say that in the future these conditions will be reversed, and the electric-light plant will supplement the power plant. Better still, they will be combined in one, and the dynamos which serve as power-generators in the day-time will also furnish light during the dark afternoons and mornings, as well as provide lights constantly in the dark corners and out-of-the-way locations. An eminently practical system of distribution appears to be two-phase alternating currents at a potential of 220 volts. This pressure is perfectly capable of easy control and insulation, and, at a very small outlay for copper, it is well adapted to extended distribution throughout large establishments, even those covering considerable ground. The question of incandescent lighting at great distances is solved by the use of 220-volt lamps, which are now on the market, and which have been proved by extended experience to be all that is claimed for them. These lamps can be wired directly across either pair of mains of the two-phase circuits, and, in fact, the ordinary mill wiring can be utilized, merely changing the lamps to 220 volts. The old 110-volt lamps can be used up by arranging one floor of a mill on the three-wire system, putting fifty or sixty lamps on each side; then the burning out of a few at a time will not materially affect the rest, and this arrangement can be continued until the supply of old lamps is exhausted. This distribution also solves the problem of arc lighting, as the wires, which run everywhere, can easily be tapped at suitable points, and groups of arc lamps, four in series, can be placed wherever wanted. If desirable, small transformers may be



AN ELECTRIC RAILWAY FOR HANDLING COAL.



AN OLD-TIME MOTOR, RUN SEVEN YEARS WITHOUT REPAIRS.

inserted, and single lamps supplied with the proper voltage for maximum economy.

And now for the motors. The pleasantest part has been left until the last; who can contemplate the modern induction motor without pleasure? No commutator, no brushes, no armatures grounding, just a simple cylinder of metal revolving on its axis. It can be placed on wall, floor, or ceiling, and left to itself indefinitely. If the motors are used to operate short sections of shafting, their switches can be left in, and they will start up in the morning with the main generators. If they are for intermittent work in small units, a single switch suffices to bring them into action. For variable speed they can be so wound that two widely-different speeds can be secured by a change in the connections of the stationary primary windings, each arrangement giving an efficiency of seventy-five or eighty per cent. in the small sizes; thus at one time the speed may be four hundred, and at another eight hundred, revolutions per minute. These motors could be built directly into the head-stock of a lathe, for instance, and a simple controller provided which would give four changes of speed of the armature, two by introducing resistance to a small extent, and two without any resistance. Either arrangement would be at an efficiency sufficiently high for all practical purposes, and, when taken in connection with the advantages to be gained by this system of distribution, would easily give the preference to electric power in small units.

THE IMPORTANCE AND ECONOMY OF PAVEMENT MAINTENANCE.

By S. Whinery.

THERE seems to prevail among urban residents and taxpayers an impression that a street pavement, if properly constructed, should require no care or attention whatever for a period of years ; that, once completed, it may be dismissed from the mind of the public and the city authorities, and allowed to take care of itself. Should the hapless pavement fall short of this expectation, they are filled with indignation, and protest, rushing to the conclusion that some one has blundered or betrayed his trust.

It is difficult to account for this general opinion that pavements should be well-nigh indestructible, or, like the famous "one-horse shay," should maintain their full integrity until a ripe old age, and then fail altogether in one brief catastrophe. Certainly there is nothing in our experience to justify a belief in the absolute permanency of street pavements.

The man who builds a house with the greatest care and without regard to expense in the selection of materials is not surprised, however much he may be pained, to find that unforeseen imperfections in materials or workmanship appear sooner or later, after the structure is completed, requiring attention and repair. The engineer who builds a railroad or a canal knows very well that the work of maintenance and repair must frequently be commenced on some parts of the work before other parts are completed, and that thereafter he must expect a constant struggle with the elements, the wear of use, and the waste of accidents. Even the bridge-builder, in whose marvelous work we might justly expect a near approach to the perfection of the poet's "one horse shay," finds that rods must be readjusted, nuts tightened, and painting frequently renewed ; and he is fortunate if no more serious defects require his early attention.

Street pavements afford no exception to the rule that all human structures decay and are impaired by use, and therefore require intelligent attention and timely repairs to maintain them in a condition of efficient service.

No one in these times doubts the great value to the citizen of good street pavements. They contribute more perhaps than any other city improvement to the comfort and convenience of the public. They promote business, and add to the material prosperity of the community. They enhance the value of property; they conduce to good health by making cleanliness and correct sanitation possible. They make an appropriate framing for the beautiful homes, surrounded by flowers and lawns, for which our American cities are noted. In short, they are both a necessity and a luxury of modern city life.

It is not surprising, therefore, that we find the subject of street pavements occupying much of the attention of both citizen and city official. No municipal problem is being more closely studied than that of how to provide our city streets with the best pavements at a reasonable cost. Able engineers are devoting themselves to this problem with the zeal its importance demands. They are studying the merits and demerits of the several kinds of pavement; they are preparing specifications for this work with the care and attention to detail that characterize the best modern practice among civil engineers in other lines of professional work. They are subjecting all the materials used to rigid inspection, in order to exclude everything that is defective, and placing eagle-eyed inspectors on the street to see that every part of the work is done in the best manner. The result is, as might be anticipated, that we are building in this country street pavements that do not suffer by comparison with the best in any country, creditable alike to the public that pays for them and to the city officials to whose supervision their excellence is due.

If the same intelligent and vigilant care were exercised in maintaining these pavements as in constructing them, their life and usefulness would be greatly prolonged, large sums of money would be saved to the tax-payers, and our paved streets would not become, as in too many cases they are, as discreditable to the community as they were creditable when first completed. Dirt and refuse of every kind are allowed to accumulate on their surfaces. The ruthless plumber, the gas-fitter, and the sewer-tapper are allowed to cut into or undermine them at will. When these have accomplished their purpose, they generally throw back the material removed without regard to the condition in which the pavement is left. Unlawful loads are hauled over them, breaking the surface or making ruts and depressions. The children build bonfires on them. In short, a street pavement seems to have no rights that the public is bound to respect.

It is not surprising that under such treatment the best of pavements come to need extensive repairs. The public and our city officials seem not to have learned the important lesson that, however well street pavements may be built, and however satisfactory they may be when first opened to use, their usefulness and beauty can be maintained and prolonged only by giving them the care that every other engineering structure must admittedly receive.

Even when the greatest care and vigilance are exercised by all parties concerned in their construction, unforeseen defects are almost sure to appear in time, either in the pavement itself, or in the various constructions under, or connected with, the pavement proper. Below the pavement is usually a net-work of pipes for various purposes, as well as large and deep-laid sewers. These are frequently not completed long enough before the pavement is placed over the trenches made for them to allow natural settlement of the material with which these trenches are filled, and little or no care is taken to properly compact the filling as it is replaced. It is not unusual to find that, by subsequent settlement of this filling, the pavement structure is left unsupported, and performs the services of a bridge as well as a pavement. As might be expected, the pavement is generally insufficient for this double service, and fails under some unusually heavy load that may be hauled over it. But, aside from such extraneous causes of failure, pavements are subjected to the destructive action of the elements, the casualties of use, and the abrasion of travel. No perfect and indestructible pavement has yet been discovered, nor will there be, for some of the qualities necessary to make a perfect pavement are antagonistic,—cannot exist together. Thus one of the essential qualities of a good pavement is that it must afford a good foothold for man and beast. Another is that it must be durable. To afford good foothold, there must be friction between the pavement and the feet of men and horses. There can be no friction without abrasion, and abrasion means destruction sooner or later.

The wear or disintegration and failure of pavements, and the consequent necessity for repairs, are due principally to two causes.

(1) If the material of which the pavement is constructed is subject to natural decay, it will in time be destroyed by this cause alone, regardless of the amount of travel to which it may be subjected.

(2) Whatever may be the natural durability of the materials of which the pavement is made, the action of the travel over it will in time wear it out. Its life will be measured by the character and quantity of the travel and the ability of the material to withstand that travel.

The frequency and extent to which pavements require repair differ with the materials used in their construction and the use to which they are subjected. Some pavements, among which may be named those properly built of good granite blocks, will require little repair, even under very heavy travel, for several years. On the other hand, a macadam pavement, however well it may have been constructed, will require constant care and attention, and more or less repair, from the time it is opened to travel. Brick pavement of the best character should need little or no repair for a time after its completion, dependent on the quality of the brick used and the amount of travel it carries. Good asphalt pavement, the material of which is an artificial composition requiring great skill and experience to properly prepare and lay, is quite likely soon to develop weak spots requiring attention, but these should be neither great in extent or expensive to remedy.

The value of any pavement and the cost of maintaining it cannot be correctly judged from the fact that repairs become necessary at a comparatively early period. In the broad sense of the word, maintenance, as applied to pavements, covers:

(1) The cost of keeping the pavement in good repair from the time it is completed until it is so far worn out as to require renewal.

(2) The cost of renewal.

(3) The interest on the sums expended for repairs from the time those expenses are incurred until the renewal of the pavement. The sum of these three items divided by the life in years of the pavement will give the true annual cost of maintenance, and is the standard by which the relative economy of maintenance of the various kinds of pavements may be correctly judged.

It is not the purpose of this paper to consider the economic value of the several kinds of street pavement from this standpoint, but it may be observed that we have as yet few complete and reliable data for the solution of the problem, especially in America, and are left to depend upon estimates more or less speculative. We have, however, enough data to warrant the conclusion that macadam pavements, where subjected to considerable travel, are the most expensive of all pavements to maintain; that granite pavements, while requiring little repairs during the earlier years of their life, cost a relatively large sum for renewal, and cannot therefore be considered economical; that wooden-block pavements, as laid in this country, while short-lived, can be renewed cheaply, and are, therefore, if judged by this standard alone, economical; and that, while asphalt pavements may require slight repairs early in their life, the cost of maintenance for a long period of years will be very moderate, which is due partly to the facts that the pavement has a permanent concrete foundation, and that the asphalt surface can be renewed at a comparatively small cost. Our experience with brick pavements is yet too limited, and the quality of the brick used too variable, to enable us to form a fair estimate of the cost of maintaining them.

It ought to require no argument to establish the proposition that the same reasons that make it desirable to construct a good pavement apply as well to the keeping of it in proper repair. If it is necessary to pave a street for economic reasons, it is equally necessary that the pavement shall be maintained in such condition as to accomplish its purpose. If a pavement is desirable for sanitary reasons, it is equally desirable that, after it is secured, it shall be kept in such condition as will best attain that end. If a street is paved for the reason that it will promote the comfort of people using it or living along it, and that it will add to the beauty and desirability of property adjoining it, certainly these ends will not be accomplished unless it is kept clean and in good repair. In short, if the pavement is considered of sufficient value to justify the expenditure of the large sum necessary for its construction, it should be of sufficient importance to be maintained in as nearly as possible its original good condition.

It is a downright waste of public funds to build good and beautiful streets, and then allow them to be ruined for the want of proper attention.

A famous saying has been so paraphrased as to read: "The price of good roads is eternal vigilance." This is forcible, but hardly accurate, the fact being that only as much vigilance and business sagacity are necessary as the good business man applies to his private business, as the efficient railroad manager applies to the care of his track, his structures, and his rolling-stock, as the prudent manufacturer applies to his machinery, or as the wise landlord applies to his buildings.

It is not possible here to go into details regarding the methods of repair. These will obviously differ somewhat with the different kinds of pavement to be dealt with, and some general observations only will be attempted.

It may first be noted that, as in medicine, "an ounce of prevention is worth a pound of cure." If pavements are properly cared for and protected, the amount of repair-work will be greatly reduced. They should be properly cleaned. While a blanket of street dirt may not be very injurious to some kinds of pavement, it will certainly greatly impair the life and usefulness of others. This is particularly true of wooden and asphalt pavements. There are the strongest reasons for keeping pavements clean, regardless of the fact that cleanliness is an important factor in maintaining them, but it should not be overlooked that the life of a pavement is prolonged, and the cost of its maintenance reduced, by keeping it clean. Pavements should not be sprinkled more than is absolutely necessary to prevent the discomfort and injury to property of flying street-dust. Proper cleaning will reduce the necessity of sprinkling to a minimum. The excessive use of water is a positive nuisance on paved streets. It reduces the dirt to a mantle of mud and slush that is more objectionable to those using the street, particularly to pedestrians, than dust. It makes thorough cleaning impossible. These should be sufficient reasons for properly regulating the quantity of water used for necessary sprinkling. When it is added that it hastens decay, increases the effect of abrasion and wear, and thereby abridges the life and usefulness of the pavement, there is seen to be abundant reason for regulating this pernicious evil. Those who doubt its destructive effect should visit a stone-sawing establishment, where they will learn that the saws used for cutting the stone would have little or no effect, were it not for the constant stream of water supplied between the saw and the stone.

Street pavements should have the usual police protection accorded to other public works. The hauling of unusual and destructive loads over them, the building of bonfires on them, the spilling on them of oils and chemicals, and the careless or accidental placing or dropping on them of gravel, broken stone or brick, and refuse of all kinds should be prohibited under penalties. While it is impossible to avoid cutting into pavements to lay or repair pipes and other underground structures, this should be allowed only under stringent and well-defined regulations. The necessity for regulating this evil is so evident that one would think that every city would adopt and enforce the necessary legislation to control work of this character; but not so. Only a small number of American cities have taken the subject in hand properly. No official, corporation, or private individual should be permitted to make openings in any pavement except under stringent regulations providing for prompt restoration of the pavement to its original condition.

If all these and other like requirements were complied with, the necessity and cost of pavement repairs would be very greatly reduced.

The one general and important rule to follow with regard to necessary repairs is to make them promptly. If this rule be strictly followed, it will be found that the cost of maintenance will be reduced to a small fraction of what it would be were the repairs to be delayed until the slight defect had become a yawning gulf in the pavement. The saying, "a stitch in time saves nine," is nowhere more true than when applied to pavement maintenance.

The passage of an extremely heavy load may cause a slight depression in a pavement in some weak spot. The wheels of following vehicles drop into this depression, subjecting it to a blow where before only a steady pressure was exerted. This will deepen and extend the depression, and, as the force of the blows increases more rapidly than the depth of the depression, that spot of the pavement will soon be destroyed; and, as the adjoining pavement is deprived of lateral support, the depression not only deepens, but extends in every direction, until it becomes an unsightly and dangerous hole in the street which it will cost dollars to repair, though at the beginning a few cents would have been sufficient. It is no exaggeration to say that, in every city having a considerable area of paved streets, many thousands of dollars could be saved annually by adopting and adhering to the policy of prompt repairs.

In most American cities the work of street-repairing is done directly by the municipality, under the direction usually of the superintendent of streets, who employs the labor, purchases the supplies, and superintends the work. In a few cities the plan has been tried of having this work done by contract, bids being advertised for and the work awarded to the lowest responsible bidder. It is still an open question which of these two systems is most efficient and economical. Against the contract system it may be said that it is difficult, if not impossible, to determine in advance the character or extent of the work required, and therefore it is impossible for contractors to submit intelligent bids; and that, under such conditions, the better and more responsible contractors are likely to bid very high in order to be safe, and the irresponsible contractors are likely to understimate the cost, or purposely bid too low, hoping, after obtaining the contract, to slight the work, in order to come out whole.

It may be further urged that a contractor for this class of city work, through political or other influence, not only might be able to obtain contracts by improper means, but, having obtained them, would use his influence to escape carrying out their terms fully and faithfully, so that the streets and pavements would be neglected and allowed to get into even worse condition than they usually are in under the direct management of the municipality.

On the other hand, it may be said that it has been the almost universal experience that cities can have their public work executed, not only more efficiently, but more economically, under the contract system. It is but natural that a contractor having a personal interest in the results of his work will look after its management more carefully than a paid official, whose salary is often not so much dependent on the efficiency of his work as upon his political influence. It is a well-known fact, the reasons for which we need not stop to examine here, that labor employed by municipalities nearly always costs more and is less efficient than that employed by private persons or contractors, and a contractor can therefore execute work at a less cost than can the municipality. Contractors in this department of public work are not more likely to resort to political influence to secure improper ends than in other departments where the contract system has been found advantageous, and this objection has, therefore, no greater weight against street-maintenance contracts than against contracts for other municipal improvements. It is, or should be, easier for city officials to compel a contractor to comply strictly with a written contract than to secure equally good service from subordinates or fellow-officials. If it were the practice to contract for the maintenance of paved streets, contractors would soon appear who would make this kind of work a specialty and thus acquire sufficient experience and knowledge to estimate closely the cost of maintaining any street, and to bid intelligently. If the mischievous laws prevailing in many States, which compel the award of contracts to the lowest bidder who can furnish an acceptable bond, regardless of other qualifications, were annulled, and the responsibility of awarding contracts thrown directly on the municipal officers, there is little doubt that contracts could be placed with responsible and honest contractors, who would engage to perform the service at reasonable prices, and would live up to the letter and spirit of their contracts. Under such conditions it is certain that the work could and would be more thoroughly and efficiently done than by the municipality, and it is equally certain that the result would be a great saving in the cost to the city of street repair and maintenance. The system might be further extended, and pavements might be constructed under contracts covering the maintenance of the pavements for a long period of years. This is already done in a number of cities to a limited extent, and the results have been most satisfactory.

It is not improbable that the apparently excessive cost of the maintenance of roads and paved streets abroad is, to some extent, due to the fact that the work is done directly under municipal or governmental supervision, and not under the contract system. American cities would doubtless rebel against the expenditure of so much money upon our pavements as is considered necessary in European cities. We can, however, learn many valuable lessons from European practice in road and pavement maintenance, and we should study especially the complete and systematic organization of this department of municipal work in France, England, and Germany, where it receives the attention its importance demands. We should aim to secure the efficiency of their systems at the least possible cost. The solution of this problem is worthy of the best efforts of our ablest municipal engineers.

CONDITIONS GOVERNING THE CHOICE OF FUEL.

By H. M. Chance.

AS the selection of boilers, and the design, arrangement, and location of a steaming plant may be materially influenced by the character of the fuel, it is advisable that this should be determined in advance of the construction of the plant. When, from any cause, this cannot be done, the characteristics of the available fuel may be investigated to determine whether the choice will not be confined to a few varieties, the peculiarities of which may receive consideration in selecting boilers, in maturing the design, and in deciding upon the location of the plant.

Except in certain localities where natural gas or oil (crude petroleum) is available, and other districts in which cord-wood is still abundant and much cheaper than coal, the only fuel to be considered is coal (or coke), and the problem will be to determine which of the various available coals will give the greatest evaporation at the least cost.

Gas-producers do not appear to have yet reached a degree of efficiency and cheapness warranting the serious consideration of gas firing for steam making on a large scale. In establishments requiring gas-fired furnaces for other purposes, it may be good policy to operate the boiler plant with producer gas, and at present the use of producer gas is probably rightly limited to these exceptional cases. The steaming plants at blast furnaces and at by-product coke ovens naturally belong to this limited class, including all those cases in which the heat of waste gases, or of combustible gases from metallurgical operations, is so utilized. When such waste gases are available, economy obviously indicates their utilization in this way, and, where insufficient, they may be reinforced by producer gas (if available) or by coal. Recent improvements in the construction and operation of gas-producers rather promise a wider use of gas as a prime motor in gas engines than as fuel for steam-making.

In the gas and oil districts, and the cities to which either or both are piped, the fuel question is not always free from difficulties. Attention must be given to the probable future cost of both or either as compared with coal, and to the element of permanency or probable duration of the supply. At some plants located in these districts it has been found necessary or advisable to make frequent fuel changes ;

and instances might be quoted of plants originally designed to burn coal which have been changed to fire with natural gas, subsequently altered to burn crude petroleum, and finally changed back to coal.

No gas or oil district yet discovered in this country has had more than a very limited life; they all become practically exhausted in a few years. It is now generally admitted that the gas or oil is held under pressure in the interstices of porous sand rocks or conglomerates (or in porous or cavernous limestone), much as a sponge holds water, and that, when these are emptied, the field is exhausted. Hence, if gas or oil be available at prices relatively cheaper than coal, prudence requires that the plant be so designed and arranged that it may be quickly and cheaply changed to burn coal.

The advantages of gas and oil firing are self-evident, and the economies effected incidentally in many ways will often make gas or oil cheaper than coal, even when their prices, as compared on a thermal basis, are much higher than coal.

The thermal or fuel value of oil may be taken, approximately, as about twice that of a fair grade of coal, weight for weight. The fuel value of natural gas, while varying widely in different districts, is distinctly higher than oil, or, say, 2¼ times the value of coal, pound for pound. For approximate estimates the relative thermal values of average coal, oil, and gas may be thus expressed:

1 ton of coal = 3 bbls.* oil = 20,000 cu. ft. natural gas.

The cleanliness of an oil- or gas-fired plant—absence of dirt, smoke, and ashes—is a cardinal merit, while the increased life of the plant, reduced cost of operation, and ability to quickly raise steam, maintain constant pressure, and instantly force the plant to its greatest capacity, are features which commend these fuels. On the other hand, it is necessary to consider the fire risk incurred by the storage of crude petroleum in quantity, and the possibility of a more or less prolonged shut-down caused by any accident to the gas-well or pipe-line. The fire risk is practically eliminated by storing the oil at a distance from the works, and the risk of interrupted gas-supply will be small, if the pipe-line is fed from several wells and is properly protected.

Coal is steadily invading the timbered regions of the south and west, and in the majority of the larger towns and cities has already displaced cord-wood as a steam fuel at large plants.

One ton of coal is usually regarded as equivalent to from two to three cords of light wood, and to about one and a half cords of hard wood.

Only where wood is considerably cheaper than coal can there be

* One bbl. oil = 42 gallons.

any question as between these two fuels. The cost of cord-wood is steadily increasing, whereas the price of coal is as steadily falling, and we cannot doubt that this tendency will continue, and that in every locality the relative cost of wood as compared with coal will increase. Hence, only the most pronounced difference in favor of wood can justify its selection, and, even where a sufficient difference now exists to warrant the use of wood in preference to coal, the plant should, if possible, be so arranged and located as to render a future change to coal inexpensive.

In a vast majority of cases in which the engineer may be required to advise as to fuel, the only question will be which of several kinds or grades of coal can be most economically used for steam-producing. In the west the problem may often be complicated by the great variety of coals available, ranging from anthracite, through all the grades of bituminous coal, to the poorer grades of lignite. Under such conditions the problem is not easily solved.

At such points as Kansas City, Omaha, El Paso, Denver, Salt Lake City, Helena, or similarly-located places the market contains a puzzling variety of fuels. Lignites, some good and some very poor, from Wyoming, Dakota, and Montana; bituminous coals (coking) from Montana, Wyoming, Colorado, Kansas, Missouri, Iowa, and the Indian Territory, some of excellent quality, others of very low grade; semi-bituminous coal from New Mexico and Arkansas; and semi-anthracite from Arkansas and Colorado,—are some of the varieties from which a choice must be made. The difficulty of selection is increased because many of these coals have not been in the market long enough to find their proper place and value in relation to those with which they are in competition, and the prices at which they are sold often bear no relation to their thermal values. Under such conditions a high-priced fuel is usually one costing more to mine, or having to be transported a greater distance, than others sold at a lower price. Such a coal may be a high- or low-grade fuel; this can be determined only by close investigation. It may be assumed in advance that such a fuel must have some special merit to commend it to purchasers; else it would find no sale at the higher price. Inquiry may develop the fact that it is cleaner and brighter-looking, or more carefully prepared, or contains less fine slack, or stands exposure to the weather, or is less smoky or "sooty," or "holds fire" over night better, or has no unpleasant odor, or makes fewer clinkers, or is well advertised and pushed by energetic management. These and many other reasons may be discovered to explain why a certain coal is more popular and commands a higher price than its competitors, especially for domestic use and small industrial works, wholly irrespective, however, of the merits or value of the coal as a fuel,—that is, of its merits as a producer of heat.

While some of the peculiarities commending a coal for domestic use are also advantageous in a steaming fuel, the value of any coal, ultimately, is measured by its capacity for producing heat. How many pounds of water will it evaporate per pound of coal, as compared with its competitors? This must always be the final measure of value, and will generally determine the choice. It is often an extremely difficult matter to decide a question of this kind, when the available coals differ widely in physical characteristics and chemical composition.

Nearly all of the large railroad systems in the west have been struggling with this problem, and, while some have solved it satisfactorily, others are yet uncertain whether their locomotive fuels are the best and cheapest available or not. In the case of these railroads the data from which conclusions have generally been drawn are compiled from the results of trial runs, or from trials extending over a considerable period. The value of the data secured in this way may be open to the objection that the conditions under which any two such tests are made are never identical, and also because the results attained are affected by the relative skill of the different firemen and engineers, and may, unconsciously, be more or less affected by prejudice for or against any particular coal. When the great railway systems, with their abundant facilities for testing, find difficulty in selecting the fuel best adapted to their use, how can one expect to make wise choice with none of these facilities at hand? It may be sufficient to answer frankly that, under such conditions, it is often quite impossible to determine in advance of the construction of a steam plant what particular coal will give the best results at the lowest cost. The best that can be will be to narrow the field down to two or three coals which appear to give the greatest fuel values at their current market prices. One method by which such an examination may be conducted has already been outlined by the writer in the April number of THE ENGINEERING MAGAZINE, under the title, "The Relative Value of Different Coals," and need not be repeated here. The calorimeter methods and results will be discussed in the closing paragraphs of the present article. Having by the method of comparison therein described selected two or three coals which give greatest promise of satisfaction, the boiler plant may be designed with a view to the use of any one of these coals, and the final selection can then be based upon the results of actual steaming trials made with each coal under similar conditions.

In the eastern and southern States the varieties of coal from which a selection must be made are far less numerous, being confined to bituminous and anthracite coals, and the range in quality is also more restricted, the poorest grades of coal having long since been driven out of the market by the better grades; there is also less difference in the market price. While the problem is simplified by the practical absence of very poor coal, and by greater uniformity in prices, it is rendered tedious and troublesome by the large number of grades from which a selection must be made, the smaller differences in fuel value requiring more careful and accurate work.

Within a certain limited distance from the anthracite coal fields, anthracite is generally the preferred fuel. It has already been shown why anthracite coal with its theoretically small thermal value is, practically, a steam fuel of no mean value.*

If anthracite coal be preferred, and the proprietors of the proposed plant desire to use it, the choice is then restricted to the selection of the particular kind and grade of coal. The considerations advanced in the article referred to above may be applied to determine the quality and value of any of the available coals, and the main issue will probably be to determine what size of coal shall be used,—Pea or Buckwheat. If the plant be provided with sufficient grate-area to burn the smaller coal without forcing the fires, Buckwheat coal will generally prove more economical than the larger size; provided always, that a good quality, reasonably free from slate and "bony" coal, be secured. The advancing price of Buckwheat coal and the poor quality of much of it shipped to market in recent years have caused some large consumers to abandon it for Pea coal or for bituminous coal. This seems to be a retrograde movement, and would be neither necessary or advisable if properly-prepared Buckwheat coal could be obtained at former prices.

For many years soft-coal miners have been urging upon consumers "run-of-mine" coal for steaming purposes, and within the last few years "run-of-mine" coal has been gaining favor, and in many districts has practically displaced screened coal as a steam fuel. By "run-of-mine" coal is meant coal as it comes from the mine, unscreened, and consisting of large and small lumps mixed with the slack coal. In a vast majority of cases screened coal is distinctly better than "run-of-mine" coal, as the screening takes out, not only the fine coal,—slack,—but also more or less fireclay and small fragments of slate. Screening, however, generally increases the cost more than it improves the quality. It leaves the miner with a large percentage of the mine yield in the form of slack, which is unmarketable and actually worthless, except possibly as coke. Hence the miner is forced to charge as much for the screened coal as he would charge for

* See article above quoted, in April number.

the same coal including the slack. For domestic and for certain special uses screened coal is worth its increased cost, but this is rarely true when the coal is used as a steam fuel.

The size and location of the plant may often exercise a governing influence upon the selection of the fuel. When the plant is small and the total cost of fuel not an important element, considerations of convenience and cleanliness may outweigh that of cost. These conditions obtaining at small plants in cities and towns, located near residences or at industrial works where smoke or soot is particularly objectionable, justify the consideration of anthracite coal, gas-works coke, or metallurgical coke (crushed or crude), which have merits especially commending them for use at such plants.

It is now many years since the use of pulverized coal as fuel for steam-making was first seriously proposed. In recent years much experimental work has been done in this direction, and the results, almost invariably, have been favorable to the adoption of this method of firing; but the introduction of many forms of mechanical stokers has retarded the development, and possibly prevented the adoption, of this method of burning coal. Pulverized coal has many of the fuel merits of oil or gas. Blown into the combustion chamber with a properly-regulated blast, it burns much as an oil or gas flame, enabling the engineer or fireman to regulate the fire accurately to varying steaming requirements. It goes without saying that, with proper regulation, smokeless combustion can be attained and maintained. As an offset to the advantages of such fuel we have the cost of pulverization, of which no reliable figures are yet obtainable. Possibly this will range between thirty and eighty cents per ton, depending upon the average size and hardness of the coal. The only use of pulverized coal as a fuel in practical work on a large scale with which the writer is familiar is that of replacing oil in firing the revolving kilns or furnaces used in burning cement. It seems entirely probable that at many establishments this method of burning coal might be used advantageously for steam-making.

While the calorimetric method for determining the thermal values of fuels is not well suited to the purposes of the engineer, in the absence of any other quick and inexpensive method it has been largely used for this purpose. The reason for the wide differences between theoretical calorific values and those attained in practical work have been sufficiently described in the article already referred to in the April number. It is evident that, under the average conditions of present practice, the calorimetric tests, in a majority of cases, fail not only to give a measure of value, but even to furnish a reliable means of comparing the actual relative values of a number of coals.

The various calorimeters are open to objections founded upon the small quantity of material used (from one to two grams of coal), the introduction of large personal errors due to the operator, the possibility of small thermometric errors causing large errors in the results, and the errors liable to occur in all apparatus requiring nice adjustment, perfect condition, and accurate handling. When proper precautions are taken to eliminate most of these possible sources of error, the instrument is doubtless scientifically accurate, and capable of closely determining the theoretical heating power or thermal value of any fuel. Such determinations do not, however, afford a satisfactory basis for deciding the choice of fuel, or for fixing the price which any fuel is worth as compared with other competitive fuels. The time will doubtless come when, in every-day steaming practice, the actual relative values of fuels will be realized, but, as this is rarely accomplished at present, relative values determined by calorimetric tests cannot always be relied upon in fuel-selection.

Some years ago the writer designed a model boiler plant to determine relative fuel values by actual evaporative tests with comparatively small samples, the minimum quantity of coal used in a test being about ten pounds, although any greater quantity could be used by prolonging the test. The water evaporated per pound of coal from and at 212° was directly determined by weight. The results attained by this means are not, perhaps, equal in value to steaming tests made on a large scale, but such tests can be made in many cases in which the cost of steaming tests is prohibitory, and, properly conducted, should furnish data more acceptable to the engineer or manager than those derived from calorimetric tests. The writer has now under construction an improved plant of this description, and will probably have it in operation at an early date,—possibly before this article goes to press.

In addition to the question of thermal values, other considerations of importance respecting the physical and chemical character of fuels may often be the deciding factors in determining choice. These relate mainly to the character and percentage of the ash and to the percentage of sulphur. Sulphur is, without doubt, the most objectionable constituent, a high percentage of water ranks next in order, and high ash is the least objectionable feature of fuel coals. As elaborated in the April article already referred to, the character of the ash, and the state in which the sulphur exists in coal, are as important as the percentages of ash and sulphur.

Other peculiarities of coal, among which may be noted their relative ability to bear transportation and rough handling, their deterioration from exposure to the weather,—"weather-waste,"—liability to spontaneous combustion in storage bins, etc., are of minor importance, but in some cases may constitute the deciding factor in determining the selection of a fuel for steaming purposes.

Much of the heat generated by any fuel is unavoidably lost through radiation, and this loss is practically a constant factor irrespective of the character of the fuel; but the losses from imperfect combustion either of the fuel or of the gases generated by combustion vary widely with different fuels, and are necessarily largely affected by the character of the boiler setting, method of firing, construction of the combustion chamber, and atmospheric and other conditions of minor importance. In firing with gas (natural or artificial) or oil, these losses constitute a much smaller percentage of the theoretical thermal value of the fuel than when firing with solid fuels, and this accounts for the much higher duty obtained with liquid and gaseous fuels than with coal and wood. With all fuels containing a considerable percentage of hydrocarbons the desideratim is smokeless combustion. Owing to the regular feeding of fuel and uniformity of air supply possible when burning oil or gas, smokeless combustion, and nearly complete combustion of the gases without much excess of air, can be maintained. With ordinary coal or wood firing this is rarely accomplished, and the soot accumulating in or on the tubes reduces the efficiency of the plant. Large installations equipped with automatic stokers are able to show better relative results and a generally higher duty, approaching more nearly the efficiency of oil or gas firing; but there is still much room for improvement both in the manner and method of burning solid fuels.

GAS VERSUS ELECTRICITY FOR POWER TRANSMISSION.

By Nelson W. Perry.

DISREGARDING, for the present, the cost of production of the gas, let us see how transmission *per se* by this means and by means of the coal cart compare.

One ton of good anthracite contains about 29,000,000 thermal units. It will produce, say, 40,000 cubic feet of gas having 400,000 thermal units per thousand cubic feet, or 16,000,000 thermal units. The best a steam engine can do is to produce a horse-power hour on a consumption of 2 pounds of coal. The ton of coal will, therefore, represent about 1,000 h.-p. hours, and this has cost to transmit by means of the coal cart 54 cents, or .054 cent per h.-p. hour.

Our gas pipes have cost $16,000. If we allow $1 per foot for laying, including special work, the additional investment would be $15,000, making a total investment of $31,000 for the pipe line. Interest and depreciation on $31,000 at 10 per cent. is $3,100. This is for a pipe line capable of delivering 1,600 h.p., or $1.93 per h.p. Allowing 8,000 hours to the year, the interest charges would amount to 0.024 cents per h.-p. hour. The energy lost in transmission at 10 inches' pressure was found to be .07 per cent. of the power transmitted, or 1.12 h.-p. hours. If power costs to generate 1 cent per h.-p. hour, the transmission charges for 1,600 h.p. would be 1.12 cents, or .0,007 cent per h.-p. hour, which, added to the fixed charges, would make 0.031 cents per h.p. for gas as against .054 cent for the coal cart.

We have used, however, 1.8 tons of coal to produce its equivalent in calorific power of gas, which seems at first sight as though it would more than counterbalance the advantages in the transmission; but, when we consider that, after we have paid the gas company what it regards as a "reasonable" profit not only on the cost to manufacture its gas, but upon the cost of distribution, collecting, etc., we can, by burning that gas in a gas engine, produce electric light more cheaply than it can produce gas light, provided we do not have to distribute our energy again electrically; and that this excess light, if not charged with the cost of distribution, can be furnished at about half the cost that the gas light can be furnished for directly from the same gas,—it becomes apparent that, notwithstanding the inefficiency of the conversion of coal into gas, the advantages of gas transmission, very imperfectly represented by the above figures, are such as to give it preference.

The gas manufacturer, however, has this immense advantage over the steam or electric-power producer,—*viz.*, that he has at his command a most cheap and efficient method of storage, which enables him to keep his generating apparatus operating continuously at nearly its maximum efficiency. This means a minimum fixed investment and depreciation charge and insurance, and—what is quite as important—a minimum labor and administration charge and the almost total wiping-out of stand-by losses.

Compare this with the conditions under which an electric light and power station is operated. Naturally the gas-light load and the electric-light load are essentially the same, and, as it exists in this country, the maximum load is seldom less than two and a half times the mean load. The gas engineer's method of storage, which involves no appreciable loss in energy and permits him to draw upon it at any rate desirable with equal economy, costs very little, per unit of capacity, and decreases in cost very rapidly with the increase in capacity. By way of illustration I quote a few figures given to me by a large builder of gas tanks. A 500-foot holder would cost about $700; a 1,000-foot holder, $900 to $1,000; a 150,000 foot-holder, about $15,000; a 3,000,000-foot holder, about $180,000, or from $1.40 per cubic foot capacity=$35 per h.-p. hour capacity, for the smallest size, to 6 cents per cubic foot, or $1.50 per h.-p. hour capacity, for the largest size mentioned.

The electrical engineer, on the other hand, in order to store his energy, must incur by that step a loss of not less than 20 per cent. of the energy stored, and must pay for his storage battery at the rate of $30 per h.-p. hour, whether the capacity be large or small. The cost of maintenance and labor to keep the storage plant in effective condition is large, and the rate at which he may draw on his supply limited.

The efficiency with which the gas engineer can transmit his energy enables him to locate conveniently to the depot of supplies, and where also real estate is cheap: and thus and in other things his expenses are reduced to a minimum.

But, if the electrical engineer cannot transmit his power as economically as can the gas engineer, he can distribute it in a form far more generally available; and this, I conceive, is the peculiar province of electricity where comparatively short distances are involved,—*viz.*, distribution, pure and simple. The best results will be obtained, where comparatively short transmissions are concerned, by taking advantage of the economies of gas transmission, and then distributing electrically over short radii,—far shorter than are now usually supplied.

Dr. Louis Duncan, in his presidential address before the American Institute of Electrical Engineers,* speaking of this problem of electrical transmission, advocated the abandonment of the multi-station method, and the concentration of the generating plant into one single station. He said: "The question arises whether we have not reached a point where it will be more economical to consolidate the stations in the *best possible location* for economical production of energy, and make use of means of distribution which have been developed in the last few years to *increase* the radius at which energy can be supplied. We may conclude that, while the practice in large lighting and traction systems is to multiply stations near centers of consumption, yet the economy of a single large station makes it important to consider whether it is not possible to concentrate our power at some point where the expenses will be a minimum, and distribute by some of the methods which have in the last few years proved successful and economical." And, in speaking of distribution for electric traction, he says: "If direct distribution is attempted from a single station, it will be found that, when the distance exceeds five or six miles, a large amount of copper must be employed to prevent both excessive loss and excessive variation of potential on the lines. Even in the city itself the supplying of sections (of a road) at distances three or four miles from the station may require so much copper that it would be less expensive to operate separate stations. Suppose, now, that we wish to feed some suburban line where the load has considerable momentary fluctuations, but where the traffic is moderately constant during the year. In this case the booster could be used with a storage battery at the end of its feeder, the battery supplying the line. The advantages of this combination are greater than with the simple booster, and in many cases they will compensate for the interest and depreciation on the battery and the loss in it."

Dr. Duncan thus appreciates fully the difficulties in transmission which I have already pointed out in the first part of this article, and his remedy, though seemingly directly the reverse of the one I would suggest, is not so radically different as it at first appears.

He advocates the concentration of all the generating plant in one station conveniently located to fuel and water, and then, in order to keep its machinery operating constantly at its most efficient load, and for the purpose of economizing copper, the placing at the outlying points of storage-battery plants from which the local distribution would take place.

I have shown that energy may be transmitted for considerable distances in the potential form of gas far more cheaply that it can be

* "Present Status of the Distribution and Transmission of Electrical Energy."

transmitted electrically, and I would substitute the gas transmission for the electrical. In order that the pipe line might be utilized to its maximum efficiency, I, too, would recommend storage at outlying centers, but I have shown that even in a gas-tank of only 1,000 cubic feet capacity, the cost per h.-p. hour storage would be less than with a battery, and in larger sizes immeasurably less and without any attendant losses. Certainly no more ground will be required for the gas-tank than for the battery of equal capacity, and the attendance charges and depreciation for the gas-holder would be but a fraction of that for the battery.

I am not so sure, however, that the storage battery might not be used to good advantage in the gas transmission, thereby enabling us not only to dispense with the gas storage at the centers of distribution, but also to keep our dynamos and gas engines at those points, as well as our gas mains, operating constantly under the very best conditions. Under these circumstances a very large holder would be erected at the gas-generating plant, enabling us to operate our gas-producers on the mean load throughout thetwenty-four hours, and to take advantage of the very great economy of gas storage on a large scale as compared with an equivalent storage in a number of smaller holders.

Where I differ with Dr. Duncan most radically is regarding the distribution of the energy. Instead of attempting to *increase* the radius of distribution, I would increase the radius of transmission and *decrease* the radius of distribution. This would decrease the variation in pressure with the same amount of copper, or maintain the variation the same with a less amount of copper. Just how far this contraction of the radius of distribution and the consequent multiplication of centers would be economical would be a question to be settled by the conditions obtaining in each case, but that it could be done to advantage in many cases there seems to be little room for doubt.

As regards the gas engine, while it has by no means reached perfection, it possesses merits which more than counterbalance its defects; but there is a large amount of popular misinformation in regard to it. In the first place, it is generally believed that it is not, and cannot be, made in large sizes. That it is not made in large sizes is chiefly because larger sizes have not been demanded. English manufacturers have for several years announced that they were ready to make them in sizes of 1,000 h. p., if demanded.

Messrs. Dick, Kerr & Co. are reported to have constructed one of 600 h.-p., but of this no details are at hand. A 320-h.-p. engine (with fuel gas), or 450-h. p. (with illuminating gas), has been in operation for several years at the Pantin flour mills, near Paris. This is of the single-cylinder type, but, if made with two cylinders, its capacity would be doubled. It has been engaged for over two years in operating the dynamos which light the mills, and other machinery.

It has been said that the larger-sized gas engines are not efficient or economical, but the facts seem to show the reverse. Mr. Dugald Clerk, in a paper on "Recent Developments in Gas Engines," read before the Institution of Civil Engineers, January 28, 1896, says that the actual indicated efficiency of a gas engine increases with the theoretical efficiency, and the actual efficiency varies between 45 and 58 per cent. of the theoretical efficiency, and the indicated efficiency increases with the dimensions of the engine, other things being similar, when the ratio of compression space, and therefore the theoretical efficiency, remains constant. Thus, he said, an engine having a cylinder 9½ inches in diameter with a length of stroke of 18 inches has a theoretical efficiency of 40 per cent. and gave an indicated efficiency of 19 per cent., or 47 per cent. of that theoretically attainable. An engine having a cylinder 14 inches in diameter with a length of stroke of 25 inches, of which the theoretical efficiency was 41, gave an actual efficiency of 27.7, or 67.5 per cent. of the theoretical efficiency. It was pointed out, however, that a limit was reached to the increase of efficiency due to increase of dimensions. But this efficiency is far in advance of that attained by any steam engine, if we include the boiler inefficiency.

It is popularly believed that the gas engine is less efficient at light loads than is the steam engine. This is not true when the two classes of engines have the same frictional losses; in fact, it is the other way, for in the gas engine there are no condensational losses such as form an important part of the inefficiency of steam engines at partial loads. In evidence of this I quote the tests made of a Crossley 80-h.-p. engine at the Bordeaux exposition, December 5, 1895.

"The engine in question was of 17-inch bore and 24-inch stroke, had one fly-wheel of 95⅜ inches diameter, weighing 17,600 pounds, and was adjusted to a speed of from 210 to 220 revolutions. The tests, which were carried on in the presence of one of the engineers of the Bordeaux gas-works, were made by belting the engine to a Thomson-Houston dynamo, and regulating the current by means of a liquid resistance. Owing to the weight of the fly-wheel, the voltmeter indicated no variation attributable to impulses from the piston.

First Test.

Loaded to about 80 horse-power:

Length of test	1 hour 15 min.
Gas consumption per hour	1316 cu. ft.
" " " kilowatt hour	32.1 " "
" " " indicated horse-power	13.7 " "

Second Test.

Loaded to about half capacity:

Gas consumption per hour	872 cu. ft.
Indicated horse power	65.8
Gas consumption per kilowatt hour	40.8 cu. ft.
" " " indicated horse-power	13.24 " "

"*Remarks.* The gas-consumption per indicated horse power appeared to be slightly better with a reduced load, the difference, however, being but $3\frac{1}{2}$ per cent.; but the indicator diagram was a little better than the average of the six others of the first test. It must be borne in mind, though, that the consumption per indicated horse-power of a gas engine changes but slightly with a change of load.

"The consumption per kilowatt hour would have been better if there had not been a heavy loss through grounds due to temporary installation and defective insulation of cables. Moreover, the belt was new, and the distance between centers of shafts quite short."

Many more tests might be cited to show that the gas engine maintains its efficiency at light loads in a way that will compare very favorably with the steam engine under similar conditions.

It is generally believed that it is difficult to govern a gas engine sufficiently closely to adapt it to electric-lighting purposes, and I believe this is true where the generators are of the alternating type and are run in parallel; but for direct-current purposes, with sufficient fly-wheel capacity, even single cylinder engines will supply perfectly steady lights at half load or less, and with double cylinders at still smaller loads. When used in connection with storage batteries, however, this nicety of governing is not so essential, and at the Belfast station, where batteries are used, the engines are belted directly to the dynamos.

The Belfast station, by the way, is the most interesting, in connection with our subject as thus far developed, that can be cited.

The system employed was decided upon by the corporation, on the recommendation of Prof. A. B. W. Kennedy. The equipment consists of six sets of rope-geared gas engines and dynamos. Four of these sets are for the general supply through feeders, and the remaining two, which are smaller, may be used either for this same purpose or for balancing the three-wire sections. The gas, which is an enriched water gas, is supplied from the city mains through two large meters. Four of the engines are of a maximum capacity of 120 i. h.p., and are used for driving four Siemens 60-kilowatt dynamos. The remaining two are coupled to Siemens 26.5-kilowatt dynamos.

The contractors guaranteed that the consumption of Belfast gas by these engines, when at their rated load, should not exceed 26.

cubic feet per electrical h.p. per hour, as measured at the dynamo terminals. If 30,000 cubic feet of this gas can be produced from 1 ton of anthracite coal, this means an electrical h.-p. hour on less than 1.8 pounds of coal,—a better result, probably, than has ever been achieved by any steam engine. By a six-hour test at the contractors' works it was found that the consumption did not exceed 24 cubic feet, or 1.6 pounds of coal, and the combined $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ efficiency proved to be about 76 per cent.

Thus far we have considered the conversion of our fuel into a carburetted water gas. Such conversion requires at the start a fair grade of coal, and, through the intermittent working necessary in all pure water-gas processes, a double set of generators. The greater cleanliness required of gas intended for illuminating purposes, and the carburation of the same in order to give the gas illuminating properties, add much to the expense of production.

Where gas is to be used solely for power purposes, a very much cheaper gas is in use, which is generally known by the generic term of Dowson gas. The process of making it consists simply of blowing, through a mass of ignited coal, superheated steam and air. This process is continuous, but makes a gas having a calorific power only about ¼ that of the carburetted water gas. It is, however, admirably adapted to gas-engine use, and is the fuel most employed in England and on the continent for this purpose.

By this process about 160,000 cubic feet can be obtained from 1 ton of good anthracite, and smaller quantities from inferior qualities of coal. While no more heat units are thus obtained from the ton of coal than by the other process, they are produced far more cheaply, and inferior and cheaper grades of coal, such as could not be used under boilers, may be used.

Dowson gas producers can be built for considerably less than the cheapest boilers; they take up less room, and their depreciation is less rapid. The attention required, too, is much less than with boilers of any class, so that, so far as the fixed charges, labor account, and cost of fuel are concerned, their economy is in marked contrast to that of the steam boiler.

As already stated, one of the most important items of expense in steam plants, when employed on variable loads, such as those of electric-lighting stations, is the stand-by losses,—the consumption of coal under the boilers while they are idle. This amounts to about ten per cent. of the total fuel consumed in an English lighting station, according to Prof. Kennedy, and probably amounts to not less than seven per cent. in those stations in this country having the best load line.

Mr. J. Emerson Dowson has very carefully determined the stand-by losses in a gas generator, and finds them so small as to be practically negligible. He built a portable generator, and placed it upon a weighing machine. In one case, after using this generator to supply 32 brake horse power, he left it on the scales with a fire in it, but without draft, for 18 hours in November. During that time there was a waste of but 18 pounds of coal.

At another time a generator which had been serving about 150 i.h.p., lost from 6 to 8 pounds per hour, and, on still another occasion, a larger generator, which had been serving from 250 to 300 i.h.p., lost 7.6 pounds per hour on standing 9 hours, and 3.9 lbs. per hour on standing 41 hours.

But even this insignificant stand-by loss is obviated where ample storage-tankage is supplied, for the fires are never banked, but are working continuously at their most economical rate.

Referring now to the results obtained from gas of this description, a test of the 320-h.-p. engine at the Pantin flour mills showed that, when working at 280 i. h. p. (220 b. h. p.), it consumed 1,295 ounces per i. h. p., or 1.03 pounds coal per b. h. p.

The consumption of water during the trials was at the rate of 1,342 gallons per hour for cooling the engine, and slightly less than 660 gallons for the washer and two generators. This gives a total of about 7½ gallons per brake horse power as against 44 to 55 gallons in the case of condensing engines.

In this country the largest gas-engine electric-lighting station is at Danbury, Conn. It has three 100-h.-p. engines operating on fuel gas. The conditions are most unfavorable for good returns, because the dynamos are not only very inefficient, being but 81.53 per cent., but operated through a jack shaft consuming over 35 h. p., according to tests by Mr. Charles E. Barry, and the size of the units is about the worst that could be conceived of to meet the lighting load of the station. In fact, a worse-planned station for electric lighting could scarcely be found anywhere, and yet the coal consumption per electrical h.-p. hour was, on full load, only 2.85 pounds, or at the rate of 262 watts per pound of coal.

But this fuel gas, while cheaper to produce, is more expensive to transmit than the illuminating gas, both because of its poorer fuel value (*viz.*, ¼) and because of its greater specific gravity (about .9). Four times as much gas must be transmitted, therefore, to represent the same energy, and, by reason of its greater specific gravity, the frictional losses under the same pressure and the same velocity will be greater. If the specific gravity were the same, it would require a pipe 20½ inches in diameter to transmit the energies calculated for the different pressures in table I, and this alone would increase the investment for pipes from $16,000 to about $27,000, making the total investment for pipes laid about $42,000. As compared with the copper required to transmit the same energy at 10,000 volts with the same efficiency, this investment is still but about two-thirds as much, but the more serious effect of using the poorer gas is the decreased capacity of the gas engine using it, which is represented in the large French engine before referred to as the difference between 450 h. p. on illuminating gas and 320 h. p. on Dowson gas,—a decrease of over 29 per cent. For every horse power required, on illuminating gas, we would, therefore, have to instal about 1.4 h. p., if Dowson gas were used instead.

The high specific gravity of the Dowson gas would render a higher initial pressure necessary, even in a 20½-inch pipe, to deliver the same amount of energy, for, if with the illuminating gas we can deliver 40,000 cubic feet with an initial pressure of 10.46 inches of water, it would require a pipe of 23 inches to deliver the same amount of energy under the same pressure. Greater pressures, however, are permissible where gas is used for power purposes, so that economy of pipe may be effected by using them.

However, in transmitting a poor and heavy gas, the expense is increased in a large ratio, and it remains to be determined in each particular case whether the greater economy of transmission, and of gas-engine and storage capacity, involved in the use of a rich gas, does or does not counterbalance its greater first cost.

There is so wide a margin, however, between the cost and efficiency of transmission for short distances of power in the form of gas over the coal cart or the electrical means that it seems that for transmission within municipalities the gas-pipe has the lead.

One of the pet schemes of electricians to-day is the substitution of electric power for steam on our elevated railroads. But, so long as the elevated roads can carry their energy more cheaply than can the central-station man, I am convinced that electricity cannot compete in point of economy with the steam locomotive.

There are conveniences in the electrical method that may, and probably will, cause its substitution for steam on the elevated roads, in spite of its greater cost by present methods: but I believe that, if gas of a suitable quality were generated on the water-front and conveyed in pipes to gas engines located at frequent intervals along the route, and the energy distributed thence electrically, the electric motor would be found both cheaper and more convenient than steam.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

II.

THE apples lay ruddy on the sward under the trees, the green leaves of the "sucker" tobacco were growing broad and long where the tall rows of the gentle herb had been cut in their bloom, and the dowager year, smug, plump, and lusty, enriched with all the wealth of departed summer, was demurely edging her garments with the pale purple of fall asters along the road-sides and meadow-edges, as I rode in late September over the trolley-line through that beautiful country between Hartford and South Manchester. The grass in the little valleys still showed the vivid autumnal green, and the trees were yet in full foliage, with here and there a maple beginning to redden, and the chestnuts and whitewoods and hickories and sassafras bushes to flaunt golden banners, so that, let the eye turn where it might, the vision was a dream of quiet beauty and gentle loveliness such as can hardly be equalled elsewhere in America. No park or ornamental ground ever matched the charm of this succession of low, wood-crowned hills and murmuring brooks, of small flower-sprinkled valleys and little green meadows, with just enough of long-ago-built farm-houses and old orchards to preserve the surpassing picture from that loneliness inseparable from a landscape without human habitation, however beautiful it may be.

Connecticut, as a whole, is a most beautiful piece of ground, and the stretch east of Hartford through South Manchester, where the Cheney silk-mills are located, is perhaps the most beautiful spot in Connecticut; and this beauty of the earth's surface at that place is, I believe, more potent than any other one agent in maintaining the harmonious relations existing between the Cheney management and its 2,500 workmen and workwomen, and in making the numerous members of the Cheney family content to remain now as closely resident owners as they were when in 1838 the four Cheney brothers,—Ward, Charles, Frank, and Rush,—impoverished by the bursting of the "Morus Multicaulis" bubble, returned to this charming scene of their boyhood days, and with difficulty gathered the few dollars needed to begin the manufacture of sewing-silk, with five or six girls at $2.50 per week as their entire force of workers.

The Cheney family is an old one in South Manchester, Timothy,

THE OLD CHENEY HOMESTEAD.

Benjamin, and Silas Cheney, three brothers, having farms side by side in Manchester in 1753. Timothy and Benjamin, in addition to being farmers, were makers of tall wooden clocks; the one example which I saw bears the name of Timothy on its dial, and now stands in a corner of the old homestead, located a short bow-shot to the eastward of the "lower mills," which was first built after the little sewing-silk-venture had expanded to the necessity of larger quarters.

John Fitch, whose invention of the steamboat preceded Fulton's conception of steam navigation, was an apprentice in Timothy Cheney's clock shop; Fulton has the honor of the application of steam to boat propulsion, and Fitch, though earlier in the field, is almost forgotten by the public.

In the latter part of last century Timothy Cheney moved from his farm, near the middle of South Manchester, to a new house, which he built near Hop-brook, where he had just erected a saw and grist and fulling mill, and in this old homestead Timothy Cheney died in 1795, leaving it to be occupied by his son George, whose sons were to inherit and exercise all the mechanical genius and business energy of their grandfather,—farmer, clock-maker, mill-owner, and man of affairs generally in the little community of South Manchester at the close of the eighteenth century. The children of George Cheney

A HOMESTEAD INTERIOR.

were George Wells, John, Charles, Ralph, Seth Wells, Ward, Rush, and Frank,—eight sons,—and Electa, a daughter.

In two of the boys the talent of Timothy Cheney developed itself along art lines, one becoming a successful and well-known painter, and the other one of the foremost steel engravers of his day.

The homestead itself, now more than a century old, low-eaved and many-gabled, full of family memorials in the way of portraits, old furniture, and paintings and engravings by the two artist brothers, is now kept as a show-place, inhabited only by care-takers, pensioners of the silk mills.

In 1836, that year of bubbles, when every cross-roads farm was laid out in town lots, and every land-owner was wealthy on paper, the silk-raising and "Morus Multicaulis" craze began.

In 1837 the bubble of land speculation burst, but the land itself remained, and the owners saw in the silk-worm scheme a way to make all their dreams of riches a reality. To plant and own mulberry trees and raise silk worms and sell cocoons was thought the sure road to wealth; "Morus Multicaulis" trees a year old sold for seven dollars apiece, and budding slips at twenty-five dollars a dozen. Countless acres were planted with young mulberry trees, on the leaves of which millions of silk-worms were to feed, preparatory to the spinning of cocoons in endless succession, the sale of which was to enrich every owner of a mulberry orchard. Charles Cheney started a mulberry-tree nursery on a farm which he owned in Ohio, and Ward, Frank, and Rush Cheney did the same on their farm at Burlington, New Jersey, where they also published a paper,—*The Silk-Grower's and Farmer's Manual.*

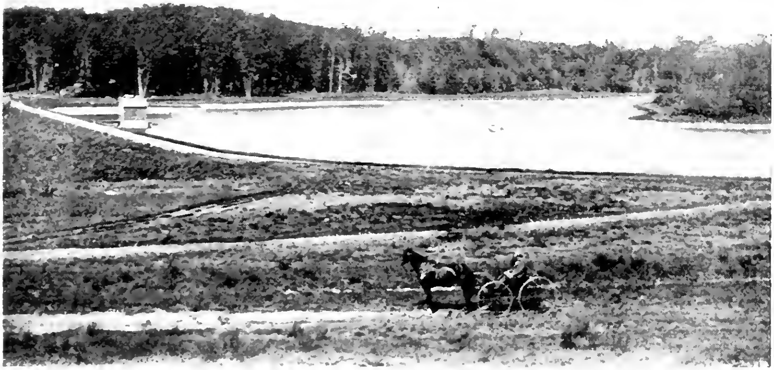
In 1839 and 1840 the Cheney brothers had not one mulberry tree left, and had plenty of money in the United States Bank in Philadelphia. In 1841 the bubble burst, and all the possessions of the four Cheney brothers gained from the mulberry business were used to satisfy their creditors, and Charles, Ward, Frank, and Rush Cheney came back to the homestead in South Manchester a little less than even with the world, so far as money was concerned,—the youngest of them at that time about thirty-five years of age,—to begin the manufacture of sewing silk on the smallest possible scale, and with great difficulty, and, as events have proved, to lay the foundation of one of the largest and most successful silk manufactories in the world. At that time, 1841, the grist, saw, and fulling mill of Timothy Cheney had passed into other hands, and was occupied as a paper mill. His four grandsons began their silk-making in a little building a short distance west of the Cheney mill on Hop-brook. Sewing-silk had been previously made in New England, and machinery for its production was bought, and the little mill started, driven by water power of course, and with a few of the neighboring farmers' daughters to operate the little plant. Here in the little mill the brothers labored early and late, adding new improvements devised by their own fertile brains, making excellent sewing-silk and finding a ready sale for their product. It may well be believed that, with the timorous expectation born of failure, the great success of the silk mill was far beyond the brightest hopes of these four brothers, and certain it is that never for one moment, from that day to this, have the attention and painstaking personal supervision of the Cheneys been relaxed. Two of the four brothers still survive,—old men, no longer in active direction of the affairs of the mills, which are now conducted by their sons, each of whom, after completing his education (always thorough in a chosen line and often including a college graduation), takes the lowest place in some department of the mills at the lowest wages paid in that department, and advances only as his ability and actual worth to the concern warrant. There are to-day eighteen of the Cheney name in the establishment, which is managed as exclusively by Cheneys as in the days of the original mill.

THE OFFICES AND A GLIMPSE OF THE MILLS.

From the first success was rapid. Building after building was added near the first shop site, now known as the "old mills," and two other groups of mills, known as the "lower mills" and the "weaving and spinning mills," have been added in South Manchester; besides which a mill weaving narrow goods has been built in Hartford. The Cheneys were among the first to begin the manufacture of spun silk, and this branch of the art of silk manipulation they have carried farther and to a more extensive and profitable development than any other manufacturer. The Cheney mills at present have about eighteen acres of floor-space, are driven by 2,500 h. p. of steam engines, and employ about 2,500 hands, half of them women. The works, ornamental grounds, Cheney residences, and the workmen's homes occupy about 1,000 acres of ground in South Manchester. In

THE SPINNING AND WEAVING MILLS.

1851 the business was consolidated into a close corporation under the name of "Cheney Brothers," with $1,000,000 capital. No increase of capital stock has been made; there are no reports of dividends, no sales of stock,—nothing save constant growth, peace, and prosperity of all concerned. The lowest estimate placed on the value of the stock by those well informed is four for one; the highest, seven for one. About 1891, the water-supply being inadequate, the company bought the manufacturing establishments on Hop-brook, tore them down, and passed all the head waters of the stream, first into a settling basin and filter bed, and then into a 50,000,000-gallon-capacity reservoir, 240 feet above the level of South Manchester. Hop-brook watershed is in a hilly country almost entirely uninhabited, and the



THE RESERVOIR.

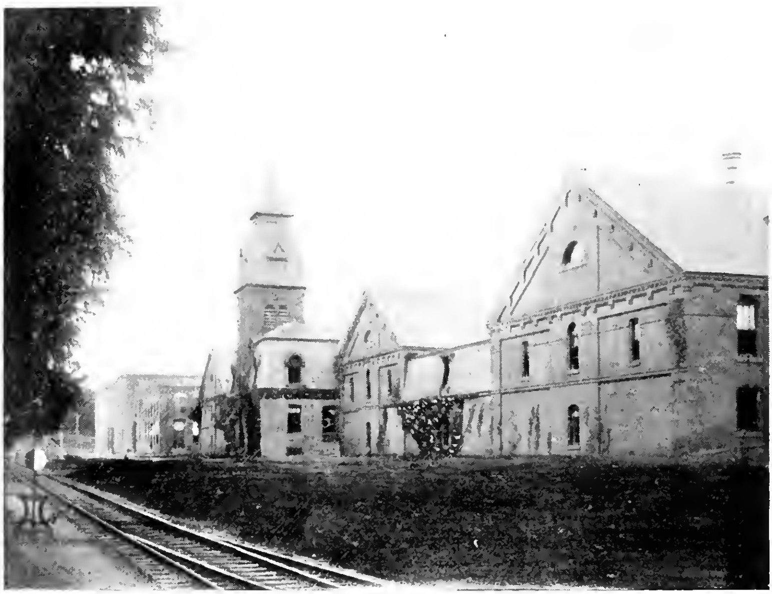
South Manchester water is of excellent quality. There are other sources of water-supply for some departments of the mills, the waters of a large spring of exceptional purity being led to the dye-houses where the more delicate shades are produced. South Manchester is about two miles south of North Manchester, a station on the New England road; about 1860 the Cheney company built a private rail-

THE SETTLING BASIN.

The filter consists of three feet of coarse hill-sand, laid on stone and drain-tiles.

way from South to North Manchester: nine daily trains connect, and through cars are run from and to South Manchester. The other industries are principally small paper mills, and these are now disappearing, so that the silk mills are making yearly approaches to complete isolation.

At first the "help" was exclusively of home production, and one of the most serious differences of opinion between the management and the hands came with the first employment of Irish girls. The "native born" held themselves high above "Irish Catholics," although there are no women in the world more industrious and capable, or more deserving of esteem for the exercise of all the virtues, than Irish girls. The principal trouble was over religion, the Yankee girl of forty years ago retaining a share of the Quaker-whipping, witch-burning, Puritan proclivities, and regarding a Roman Catholic with horror. All of this has disappeared long ago; the religions and politics of South Manchester are what might be expected in a mixed community of American, English, Irish, Scotch, German, and Swedish nativity. The management imposes no restriction of any sort upon its workers. There is no organization of labor, and "no representation of labor" in the business. Wages are paid almost wholly on the piece-work plan. For a certain prosperous year, when times were



FRONT OF SPINNING AND WEAVING MILLS.

STATION ON THE CHENEY PRIVATE RAILROAD.

"good," the average pay in various departments was as follows:

	Males.	Per week.	Females.
Raw Silk Winders	....	....	$6.00
" " Cleaners	....	....	4.25
" " Doublers	....	....	5.75
" " Spinners	$10.00	...	5.75
" " Twisters	10.00	....	5.75
Soft " Winders	7.00	....	6.30
" " Spoolers	....	....	5.00
" " Warpers	10.50	...	6.50
" " Warp twisters	18.00	....	....
Weaving Broad goods	11.84	....	8.80
" Ribbons	9.00	....	7.00
Designers	25.00	....	....
Card cutters	18.00	....	....
Dyers	9.00	....	....
Finishers	12.00	....	....
Laborers	$7.50 to 9.00	....	....

The low pay was given as $3.50 per week.

In this year there were, out of 2,500 hands employed,

88	men	obtaining	weekly	$10 to $12.
104	"	"	"	12 " 15.
96	"	"	"	15 " 20.
24	"	"	"	20 " 25.
46	"	"	"	$25 and over.

A WORKMAN'S COTTAGE.

The high women's pay was given in that year as, in the case of one woman, over $12 and under $15, the next highest being that of 37 women, whose wages were over $7 and under $8 per week.

These wages are, I believe, better than cotton-mill workers obtain, but not so great as to be very tempting to the mass of American toilers. Out of 2,500 hands the total number obtaining over $10 weekly is only 358, leaving, say, 2,242 paid over $3.50 and under $10 weekly. As about half of the workers are males, it seems likely that the average skilled workman's pay is not over $8 or $9 per week.

Some, not many, of the retired workers are pensioned. There are many hands in the mills who have been in service for forty years and over. The company owns about two hundred rented tenements of a very superior class; the rents vary from $5 per month up to $12 and $14. The tenements are widely-separated cottages. The difference in price is due mainly to location: there are "aristocratic" and "plebeian" workmen's quarters among the company's tenements, besides which nearness to the works and other considerations make some locations more desirable than others. In cases of hardship, such as sickness or long-continued short-time, concessions are made, rents written off, and straight-out charity bestowed, although giving of money is very strongly deprecated by the management. "Once give out money, and you make a perpetual pensioner,'' was the way it was expressed.

''Any one can do what we have done,'' said one of the Frank Cheneys to me ; ''let any man, or two or three men, take any sound business, start small, do good work, and give their whole time and attention to the business, and put every dollar it earns back into the establishment, excepting only a fair salary for the actual work done by the managers, and they must succeed. That was all the Cheneys did : we have made no great or controling invention ; we have not originated any methods of startling novelty ; we have kept ourselves informed ; we have used what faculties we had ; we have all lived right here, with our help about us, and treated them fairly. We do not pay high wages ; we do not share profits ; we have never heard of any plan which in our judgment would better our present course of operation. The children of our workmen often go into the mills. Some of our help goes away ; most of it comes back, homesick. We encourage workmen to own homes. We sell land at from one to two cents per square foot, according to location. We have here in South Manchester a strong building and loan association, which has many of our workers among its members. We never took care of the savings of our help, and there is no savings-bank here ; Hartford has the nearest. When a man has a

A WORKMAN'S COTTAGE.

home and a wife and a little furniture, and is comfortably situated, he is not likely to make any change." "Yes," was said in answer to a question, "we have had some disagreements; they cannot be avoided; but nothing has ever led to any serious trouble. We object to the sale of liquor, and the town is sometimes 'dry' and sometimes 'wet'; this year it is 'wet,' and we have about twenty licensed drinking-places, but there is a good deal of liquor sold here when the town is 'dry.'"

Another Frank Cheney believes that isolation is the principal cause of the harmony existing in the Cheney silk mills. This speaker also very strongly favored prohibition.

Neither of these gentlemen laid much stress on the beautiful sur-

CHENEY HALL.

roundings of the South Manchester homes. The "Park," or grounds, in which both the factories and the Cheney residences stand is about one hundred acres in extent, and is beautiful beyond description, with a quiet loveliness and all the charms which nature, vivid and vivifying, can exercise upon mind and heart.

The dwellings of the workmen are contiguous, and have a similar environment. The Cheneys themselves are contented to pass their lives in South Manchester, because they can nowhere else find so delightful a harborage. The workmen remain for the same reason, and because their time is full of light labors, with simple enjoyments in easy reach. Cheney Hall is a free assembly-room, with ample accommodations for gatherings of all kinds. It is located just one side

A GROUP OF CHENEY RESIDENCES.

THE NINTH DISTRICT-SCHOOL BUILDING.

of the middle of the works, and, in effect, is the sole property of the help. The Cheneys built it, heat and light it, and pay a janitor two dollars a day to take care of it, and the hands use it at will. It is constantly in service.

The Cheney School is conducted on admirable lines, devised by Secretary Charles D. Hine of the State board of education ; it is located in the ninth school district, which had in 1894 an enumeration of 1,003 pupils ; the school was built by the Cheney corporation, and its use given, rent free, to the district. It has provision for a large kindergarten, a workshop, a gymnasium, and a cooking school, and there are large collections of books in each of the rooms, which are very numerous and used for not more than twenty-five pupils each. Children are taken in the kindergarten at the age of three years ; wood-working and mechanical drawing are taught in the workshop. The educational course is thorough, varied, and high enough to meet the requirements of the most ambitious pupil.

One of the Frank Cheneys, who drove out to the reservoir and settling basin with me, a young man who can choose his own life, chooses to be mechanical director of the establishment, and personally conduct the machine shop ; his pleasures are those of the horologist, Timothy, and his delight is the delight of his father, now near fourscore, who said to me : "It is a great pleasure to work." The wood through which the reservoir road lay was beautiful with autumn foliage, and, in response to my expressions of admiration, this Frank

Cheney said that he had seen no place in the world save New England where he would care to live, and, of all of New England that he had seen, South Manchester was to him most desirable as a place of residence.

It is so with the Cheney hands: they are healthy and happy; they live now in so beautiful surroundings that no change can improve them, and those who try a change to Paterson or the other silk-manufacturing places very seldom stay long away. For the young workmen their work by day and the full social possibilities found in a constant succession of lodge meetings and social events fill their minds. The older men see their wives in comfortable homes and their children in one of the best schools in the world; the unmarried, of whom there are considerable numbers of either sex, have the life they choose to have; what more need be said?

South Manchester is not so strait-laced as Whitinsville, and it is possible that the management at South Manchester is something less of a special providence to each separate individual than at Whitinsville; in both places the women walk with elastic steps and wear red in their cheeks; easy work, pure water, fresh air, and comfortable homes are the common lot: what could these workers expect to gain by change?

From the beginning the Cheney mills have had a finely-equipped machine shop and skilful and ingenious workmen. Christopher M. Spencer, inventor of the Spencer automatic screw machine, of which

A GROUP OF SCHOOL-CHILDREN.

a thousand are in use by the Hartford Machine Screw Company alone, was one of the Cheney shop-foremen. He is also the inventor of the Spencer rifle, over 100,000 of which were in the field in the last year of the war of the rebellion. The Spencer rifle was fostered and developed by the Cheney management, which at one time had half a million dollars written on the wrong side of the rifle account; but the last year of the rebellion the Spencer rifle factory in Boston, under the management of one of the Cheney Brothers, ran on an open order for unlimited production, and made money to about balance the ledger. The "Grant reel," invented by Mr. J. M. Grant, who was

THE MACHINE SHOP.

for about forty years one of the Cheney workmen, is now largely used in European silk works as well as in China and Japan. These are examples of the more prominent novelties emanating from the Cheney establishment, but, taking the business as a whole, its great success has not been due to any series of great and revolutionizing inventions, but, rather, to a constant series of small detail improvements, coupled with unremitting personal attention and that thorough personal knowledge of every detail of silk manufacturing gained by the actual performance of workmen's duties which has been in all cases a part of the education of the Cheney managers.

The Whitin Iron Works and Cheney Silk Mills show the very great advantages of isolated manufacturing plants and resident owners and managers, each thoroughly familiar with some branch of the operations carried on. Isolation gives opportunity for beautiful surroundings, pure air, and agreeable living conditions, which make the workers healthy, happy, and contented, and also reduce the workmen's living expenses to the lowest terms, and favor the growth and education of successive generations inclined by heredity to become efficient and docile operatives. It would be difficult, indeed, to content the Whitinsville or South Manchester employees with homes and home-surroundings afforded by the sordid tenement-houses and treeless, unlovely streets of the tenement districts of any of our large manufacturing centers, and it is extremely improbable that any "labor agitator" can ever succeed in "organizing" the workmen of such an environment as that which obtains in Whitinsville and South Manchester. At South Manchester, when the Knights of Labor were at the height of their prosperity, a lodge was organized, but it died a natural death without the slightest interference by the Cheney management. There are too many agreeable social diversions at South Manchester to make the dreary mouthings of the professional labor agitator an attractive entertainment, and, without the professional labor agitator, the paid "walking delegate," the paid "committee of adjustment," and all that horde of labor parasites which subsists on labor troubles, organized strikes become impossible. Hence lightly-worked hands, who have life enough left at the close of the day's labor to take part in some social amusement, and who have means to please themselves, lend a deaf ear to the blatherings of the labor-dissension "hireling," and turn with disgust from the prospect of a contest with their employers. Undoubtedly isolation, beauty and healthfulness of surroundings, and the ready means of amusement furnished by Memorial Hall in Whitinsville and Cheney Hall in South Manchester are the principal factors in the harmony with which labor and capital combine their efforts for mutual good at the Whitin Iron Works and Cheney Silk Mills. These means are not available in a mural environment, and two of the six examples of successful management to be treated in this series of articles will show the totally different means by which establishments located in cities are enabled to reach equally harmonious and desirable relations with their workmen. Without question, however, taking the greatest good of the workman and his family and the lowest possible cash cost of product as the chief desirabilities of attainment, these two examples very strongly indicate isolation as the ideal condition for manufacturing purposes.

THE RELATION OF INVENTION AND DESIGN TO MECHANICAL PROGRESS.

By C. L. Redfield.

THE expression, "mechanical progress," as here used, may be defined as "progress in the science and art of utilizing the forces and materials of nature in the construction of machines."

Such progress is of four kinds: first, the discovery of new laws, forces, and materials; second, the invention of new ways of utilizing what has been discovered; third, improvement in the design of structures embodying inventions; fourth, increased skill in the making and handling of what has been designed. These are well-defined divisions, and each calls for a peculiar quality or action of mind. So distinct are they that it is not common to find a person who is master of more than one of them, though they are not incompatible with each other for one having the proper education and training.

Discovery is not an active mental operation, but an exercise of alertness in observation. Invention, on the other hand, is a purely intellectual process that seeks to combine forces and bodies so as to produce new results. Design is the product of a knowledge of the laws and materials of nature joined to a sense of the fitness of things. Skill is an acquirement attained by practice upon one thing or class of things. Of these four elements relating to the progress of mechanics, invention and design are most intimately associated with each other. Discovery is more closely connected with invention than with design; skill more closely with design than with invention. All are more or less interdependent, and each at times makes use of the others in its development.

The discovery of new laws, forces, and materials is not common at the present time. What there is of discovery is principally confined to finding new results of known laws, and is invoked as an aid to invention and design. This is not due to a scarcity of individuals who would make competent discoverers, if there were a large and remunerative field for their services, but to the fact that it pays better to do something else. Too many discoverers, whose capacity does not warrant them in going beyond their legitimate field of operations, are engaged in the work of invention, in the fond belief that they are inventors. Not a few of them are successful, but it is not because they ever invented anything, though the law gives them credit for having done so.

"Striking it right" is not the act of an inventor, but that of a discoverer, who, by the mere multiplicity of attempts, insures the ultimate finding of the right way, provided his money and patience, or that of his backers, do not give out. This discovery of invention—if I may be permitted to use so paradoxical a term—is not a little assisted by suggestions from others, which tend to guide the experiments into the right path.

The discoverer who becomes successful in invention in time learns wisdom, and, instead of going through endless experiments, employs another to make the invention he wants. This practice, while legally permissible, is ethically wrong, in that it gives the work of the actual inventor to a person who merely had an idea that such an invention would be valuable. In saying this, I do not wish to be understood as impugning the motives of those who indulge in this practice. They doubtless believe themselves the actual inventors, and the conversation of their friends and attorneys strengthens that belief.

I have said that invention is a purely mental process. It is also a mental process of a peculiar kind, though by no means rare. The inventive faculty, so called, is possessed by thousands who make no pretensions to it, and who know almost nothing of mechanics. It is essentially imaginative, and is practically identical with that which produces the plots of plays and novels, and the theories and hypotheses of science. In its practical application, invention is like the solution of a puzzle,—a struggle to do what one knows not how to do.

Invention, *per se*, does not require an extended knowledge of mechanics, but some familiarity with the laws of nature is essential to the making of any invention, and, the greater this familiarity, the more effective and skilful the inventor will become. In making this statement, a distinction is drawn between mechanics and the laws of nature. The former has reference to what man has made, the latter to mechanical principles in the abstract. Studying the laws of nature necessarily involves studying the works of man, and there is a point, determined by the mental capacity of each individual, beyond which increased learning in mechanics is positively detrimental to the ability to make inventions. This is particularly true when learning takes the form of exhaustive study of what has been made by others, and the lines along which others have worked. Study of this kind tends to narrow, instead of broaden, the mind, and to get the individual into a rut from which he cannot escape. This may be illustrated by a circumstance taken from the commercial history of Great Britain. For many years England has had control of India, and her ships have carried the manufactures of the occident to exchange for the products of the orient. When this trade first became valuable, efforts were continually made to reduce the time during which goods were held in transit. To accomplish this, larger and finer vessels were built, and were equipped with better rigging or more powerful machinery, and the science of navigation was utilized to its limit. When this had reached a stage where it became evident that further progress in the economy of time would be slow, a man who knew nothing of navigation, and next to nothing of naval architecture and steam engineering, came forward, and, by cutting a canal across the isthmus of Suez, made it possible to take any old tub of a boat from England to India in less time than the swiftest vessel afloat could ever hope to go in the old way. Study of the laws of storms, practice in the art of navigation, improvements in the contour of ships, and inventions relating to marine engines would never have cut that canal, and, the more strictly the minds of engineers and navigators were centered on these things, the less likely they were to evolve that short route. The simple cutting of a canal is not invention, but its construction in connection with the purposes for which this one was made accurately illustrates what invention is.

Design bears about the same relationship to invention that skill in literary composition bears to the story to be told. In its common acceptance, it is supposed to relate to the form and shape of pieces; but it goes further than this, taking in the arrangement of parts and their coöperation, one with another. In this work it often encroaches upon invention by producing new and useful results. Design does not call for the same degree of imagination that invention does, but it requires a more thorough knowledge of physical laws and a sense of the artistic. The inventor is not usually a designer, though he may be. Many inventors without the designer's qualifications are acting as designers in respect to their own inventions. Inventions dressed in crude garb represent only the foundation on which design constructs that which truly represents progress progress in mechanics.

Design applied to machines is a comparatively new and untaught art, and few have mastered its intricacies sufficiently to enable them to produce good work, pleasing and adapted to the materials used. Ornamentation of the kind employed in other arts is not generally applicable to cast iron, and cast iron is the material in which the majority of designs are executed. The stag is a handsome, graceful, and well-built animal, and his head is crowned with a pair of antlers that are both useful and ornamental, but, if his legs had been constructed on the plan of his horns, he would have been extinct ages ago. How little some of our would-be designers understand what is appropriate can be seen from the numerous lines of machines which are supplied with legs that look as if they were patterned after the horns-of a deer.

A machine is preëminently an article of use. Therefore correct design in a machine requires that each part should take that form which is best adapted to its use, and an outline that will indicate the character of its use. This requirement of the details is qualified to the extent that no piece should be of such form and construction as to be out of harmony with the whole. The worst and most objectionable feature of many machines is that certain parts give the appearance of having been after-thoughts. No design can be true that does not previously contemplate all parts of a machine, and bring each into its proper relationship to the others. It, therefore, follows that the designer should have in his mind at the outset a complete understanding of its operation, its uses, and the conditions to which it will be subjected. Premising these conditions, and skill on the part of the designer, the result will represent satisfactory progress.

Design in architecture rests upon well-established traditions as to what is excellent, and is carried out by persons trained and educated in the art. Design in machinery has no such foundation, being, for the most part, in the hands of comparatively young and inexperienced men,—men between the ages of twenty and thirty. Reason for this is found in the fact that the value of excellent designs is not generally appreciated, and certainly not appreciated as it should be. The result is that designing, as a profession, receives scant remuneration, and, as the man who is competent to become a good designer is also competent to become something else, he soon drifts into other channels.

In spite of all handicaps, there is a steady improvement in the quality of machine-design. At present we find this improvement in forms and shapes that are at once pleasing to the eye and satisfactory to the sense of fitness. Forms and contours that are good and proper have something intrinsic that conveys that impression to the beholder, even when he has but a slight knowledge of the qualities of the materials in which the design is executed and but an imperfect sense of the artistic.

Of all the forms produced in machine design there seem to be but two that deserve to be perpetuated. One is what may be designated as the hollow pedestal, and is well illustrated in shapers and milling machines. Rounds and ovals harmonize with this, as do all massive forms that have a smooth and unbroken exterior. The other may be called the I-beam form, and is especially applicable to frame-work. In many cases it gives the best possible distribution of metal, and produces an appearance of beaded panel work. Sections in the form of crosses, Ts, and Ls, harmonize with this, as do smooth surfaces when they terminate in pronounced beads. The massive or pedestal form is applicable to straight lines or long sweeping curves, as is illustrated in punching-machines and the Porter-Allen engine and its copies. The panel, or I-beam, form should never have the sweeping curve on more than one side of a given panel, and then only when it serves a distinct purpose of which the outline gives evidence. Curved legs, whether of the I, T, L, or hollow form, are obviously wrong, because their outline does not correspond with the lines of force that they are intended to resist.

An illustration has been given of how invention outstripped design in carrying ships quickly from England to India. On the other hand, if we carefully compare the ocean greyhound of to-day with the dug-out of primitive times, we will find that nearly all that goes to make up the difference is the product of design, and not of invention. Again, James Watt built engines a hundred years ago, and we build engines to-day. Numerous and important inventions relating to steam engineering have been made since the days of Watt, yet our engines are not more durable, and scarcely more economical, than those prototypes. They are, however, of better form and more convenient, and they furnish more power for their size and weight. These results are principally due to improvements in design, and to designers should be given the credit.

We have the well-recognized professions of doctor, lawyer, minister, engineer, and chemist, and we have schools for the education and training of each; not so with designers of machinery and mechanical appliances. Individual designers we have, but their number is few. As a result, improvements in design are sporadic, and often have their origin in accident or sudden inspiration. Once a design is made, its excellence is quickly recognized and largely copied. This copying of design may, in the absence of a sufficient number of competent designers, be beneficial to mechanics in general, but it is a source of much complaint from those who have their designs so copied. The justice of such complaints may be questioned, not because the copyist has any right, legal or honorable, to appropriate the product of another's brain and skill, but because the very person who makes the complaint is often guilty of claiming as his own that which was in reality made by some one else,—probably some poorly-paid draughtsman. When manufacturers of machinery shall properly compensate skilful designers, and give credit where credit is due, then the best talent will be drawn into this art, and copying will cease. There is no more reason why the originator of an excellent design should not receive credit for his skill than why an author should not receive credit for what he produces.

Invention is analogous to the plot of a story or the ideas and sentiments of an essay; design finds its counterpart in the phraseology and manner in which the story is told or the ideas and sentiments conveyed. Literature covers the story and the way it is told, and mechanics covers the invention and the design through which it is carried out. Many stories may be told from a single set of characters, and each story may be told in many different ways. Many inventions may be founded on a single discovery, and many designs may be made for carrying out a single invention.

Inventors we have, and always will have. They are a natural product, needing but the stimulus of incentive to bring forth their best efforts. This stimulus exists in the form of patent laws framed for their protection and benefit. Designers we have not; neither are they a natural product; they must be raised, trained, and educated. We have no schools for their training, and we furnish no incentive for their development, nor do we give encouragement and credit to those who enter the field. Yet it is from designers—designers of machinery—that we must expect the most substantial part of our future progress in mechanics.

While it is true that designers are not born, but educated, it is also true that the successful designer must be born with some qualities of mind that all persons do not possess. First, he should have a sense of the appropriate; second, he should have a capacity for acquiring special and general information; third, he should have the faculty of observing and perceiving what is and has been done; fourth, he should have the ability to control the other elements with judgment and common sense.

Premising these qualities in our prospective designer, how shall we educate him? Whatever plan or course be adopted, he should not be subjected too rigidly to rules and precedents; else he will become dogmatic in theory and a copyist in practice. The ideal designer is bold in conception and conservative in action. He studies the forms of nature, and adapts them to the practice of man. He analyzes the work of his predecessors, and compares it with natural forms, and he seeks the reasons why natural forms are as they are. But this is not all. Many forms that are desirable in themselves are impossible of construction with our present appliances, or so costly as to be prohibitive, except as works of art. The ever-present question of dollars and cents, and the fact that designs involving dynamics are different from those involving statics only, compel our student to carefully consider what can, and what can not, be made, and the relative cost of making things in different ways. The study of these things will send him to the pattern, machine, blacksmith, and boiler shops, to the foundry and the rolling-mill; on the thoroughness with which he comprehends the processes employed will depend his future usefulness.

ABSENCE OF A STANDARD IN BATTLE-SHIP DESIGN.

By Ridgely Hunt.

THE purpose for which a battle-ship is designed, built, armed, and put in commission is to fight on the high sea against some other battle-ship. It follows, therefore, that, in each ship constructed for this purpose, the attempt is made to have her the superior of any enemy's battle-ship she may be called on to encounter. In examining the attempts of naval experts to put afloat an impregnable vessel possessed of the highest powers both of offence and defence, little agreement in regard to some of the most important particulars is observable; hence, until battle-ship meets battle-ship in mortal combat, no just estimate of the superiority of the distinctive features of the one over those of the other can be properly made.

To select an ideal ship as a standard and measure the efficiency of existing ships by her is objectionable. For instance, there are some well-informed men who believe that a 10-inch gun is the largest piece a battle-ship should mount; other experts, quite as capable, advocate 13-inch, or even larger guns. A like diversity of opinion is noticeable in regard to the thickness and the distribution of the armor; and the same is true concerning the speed. In short, scarcely a single feature is accepted without more or less condemnation. The result of so divergent views can be best appreciated by overhauling the data of the latest and presumably the best-designed battle-ships now being built by the principal naval powers of the world.

Of course, everything superlative is not to be found in a single ship; the aim is to so compromise the desiderata as to secure the best possible. Size is a good element in a battle-ship; it insures the best sea-keeping and sea-going qualities and the best speed. Besides, it permits of almost any distribution and thickness of armor and the emplacement of the most powerful armament. But beyond certain limits great size is impracticable. The expense of construction and afterwards of maintenance, the unwieldiness of such masses, and the size of dry docks are some of the deterrents; and the depth of water to be found in most of the harbors of the world is another serious obstacle. Finally, there is no certainty that a torpedo might not, by a single successful blow, destroy the whole expensive structure.

The following table gives dimensions and other particulars of the typical ships now occupying the attention of the navies of the world.

Name	Armament.	Foot tons of muzzle energy per gun.	Rounds per minute.	Total energy in ft. of each class of gun per minute of fire.	Energy per ton of displac'mt
MAGNIFICENT	4 12	33,900	4/6	22,600	13.0
	12 6	3,360	30	100,800	
	16 12 Pdr	425	160	68,000	
	12 3 Pdr	80	144	11,520	
	44	37,765	334 4/6	202,920	
ROYAL SOVEREIGN	4 13.5	36,000	4/6	24,000	11.6
	10 6	3,360	25	84,000	
	16 6 Pdr	280	176	49,280	
	9 3 Pdr	80	108	8,640	
	39	39,720	309 4/6	165,920	
RENOWN	4 10	14,430	4/6	9,620	11.2
	10 6	3,360	25	84,000	
	8 12 Pdr	425	80	34,000	
	12 3 Pdr	80	144	11,420	
	34	18,295	249 4/6	139,040	
CHARLEMAGNE	4 11.8	30,000	4/6	20,000	20.0
	10 5.5	3,300	50	165,000	
	6 4	500	51	25,500	
	16 3 Pdr	80	192	15,360	
	36	33,880	293 4/6	225,860	
CARNOT	2 11.8	30,000	4/6	10,000	11.7
	2 11	22,750	4/6	7,583	
	8 5.5	3,300	40	132,000	
	4 6 Pdr	280	44	12,320	
	16 3 Pdr	80	192	15,360	
	32	56,410	276 4/6	177,263	
E. FILIBERTO	4 10	14,430	4/6	9,620	16.2
	8 6	3,360	20	67,200	
	8 5	1,100	52	57,200	
	8 6 Pdr	280	88	24,640	
	28	19,170	160 4/6	158,660	

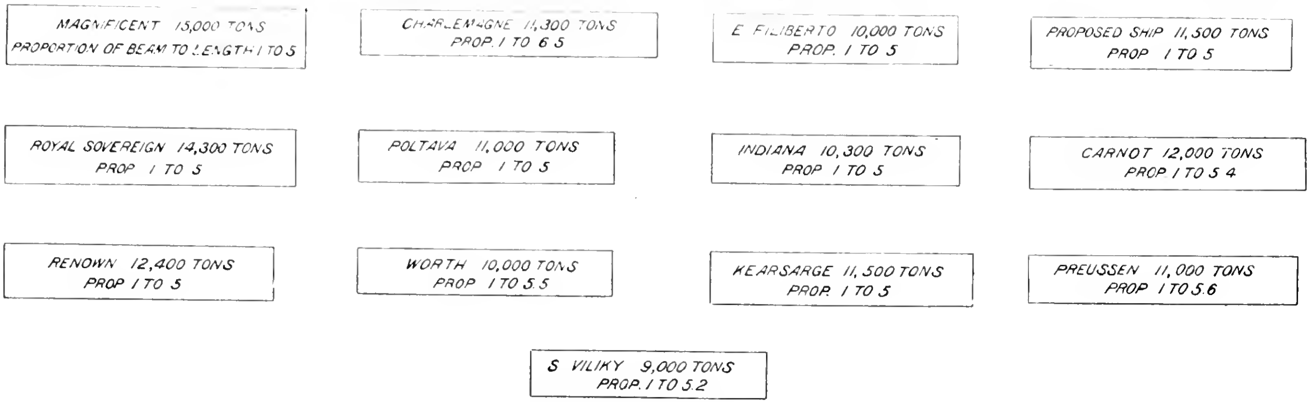
Name.	Armament.	Foot tons of muzzle energy per gun.	Rounds per minute.	Total energy in ft. of each class of gun per minute of fire.	Energy per ton of displac'mt
WÖRTH	6 11	22,750	1	22,750	9.0
	6 4	500	51	25,500	
	4 3 5	440	40	17,600	
	8 6 Pdr	280	88	24,640	
	24	23,970	180	90,490	
PREUSSEN	4 10	14,430	4/6	9,620	21.6
	18 6	3,360	45	151,200	
	12 3 5	440	120	52,800	
	24 3 Pdr	80	288	23,040	
	58	18,310	453 4/6	236,660	
S. VILIKY	4 12	33,900	4/6	22,600	29.4
	6 6	3,360	15	50,400	
	12 3 Pdr	80	144	11,520	
	22	37,340	159 4/6	84,520	
POLTAVA	4 12	33,900	4/6	22,600	12
	12 6	3,360	30	100,800	
	10 3 Pdr	80	120	9,600	
	26	37,340	150 4/6	133,000	
INDIANA	4 13	34,000	4/6	22,666	12.3
	8 8	8,100	2 6	21,060	
	4 6	3,360	10	33,600	
	16 6 Pdr	280	176	49,280	
	32	45,740	212 4/6	126,606	
KEARSARGE	4 13	34,000	4/6	22,666	20 5
	4 8	8,100	1 3	10,530	
	14 5	1,800	91	153,800	
	16 6 Pdr	280	176	49,280	
	38	44,180	269	236,276	
PROPOSED SHIP	4 13	34,000	4/6	22,666	16.5
	14 6	3,360	35	117,600	
	16 6 Pdr	280	176	49,280	
	34	37,640	211 4/6	189,546	

Great Britain is building the largest-sized battle-ships; elsewhere 10,000 and 12,000 tons are, for the time being, the limits. These figures, excepting in Italy's new ships, have been reached by gradually enlarging each succeeding ship, and there is no reason to take them as final. In order to show graphically the relation existing between the sizes of the battle-ships now being built, the accompanying diagrams are submitted; assuming that the drafts are equal, the length and breadth of the rectangle respectively represent the length and beam of the ship, and the area, the displacement tonnage.

To discuss the relative value of the armaments of these battle-ships is difficult; yet the gun power is considered, other things being equal, the determining factor of the powers of offence. In fact, a battle-ship should be designed for her armament, for, if this be not properly installed, rapid firing will be impossible. In order to compare thoroughly the fighting value of the armaments of two ships, the following elements would have to be taken into consideration: (1) the various calibers and the weights of the projectiles; (2) the initial velocities; (3) the number of guns constituting the armament; (4) the number of rounds which can be fired by each caliber in a certain time; (5) the field of fire of each gun; (6) the ease with which the different guns can be trained on an object; (7) the accuracy of fire and the chances of useful firing,—conditions which vary in large calibers and in rapid-firing guns; (8) the speed of the ship and her manœuvring powers. Since such comprehensive data cannot be obtained, perhaps the total striking energy of the battery will be sufficient for the purposes of general comparison. In ascertaining this, the batteries should be classified as follows: (1) large-caliber guns, from eight inches upwards; (2) rapid-fire guns, from four inches up to seven; (3) rapid-fire guns of less caliber than four inches, and throwing shot weighing more than one pound.

The value of fire from the different classes of guns varies in other respects than those of tons of striking energy. A rapid-fire gun can easily throw a greater weight of metal in a minute than a large-caliber gun, but it would be misleading to estimate the former at the same value as the latter, for this depends altogether upon the circumstances. So, when instituting the comparison of the battery powers of different ships, the guns of the armament should be classified, and their powers should be reduced to a unit of time. With this method of comparison, it is possible to show approximately the effect of substituting rapid-fire guns for the slower guns of larger caliber, but it should be borne in mind that the smaller gun is not a match for the larger gun when armor is to be pierced. The following table of practical firing-speeds is abstracted from a navy-department publication.

NAME.	Flag.	Displacement. Tons.	Dimensions. Length Feet.	Dimensions. Beam. Feet.	Dimensions. Draft. Feet.	Protection. Belt.	Protection. Side.	Protection. Turret.	Protection. Small Guns.	Protection. Deck.	Armament.	Speed Knots.	Normal Coal supply. Tons	I. H. P.	Estimated Cost. Dollars.
Magnificent...	Eng.	14,900	390	75	28	9	9	14	6	4	4 12", 12 6", 16 12 pdr, 12 3 pdr.	17.5	900	12,000	4,561,000
Royal Sov'r'gn	"	14,300	380	75	28	18	4	17	6	3	4 13.5", 10 6", 16 6 pdr, 9 3 pdr.	17.5	900	13,000	4,500,000
Renown......	"	12,350	380	72	27	8	6	10	6	3	4 10", 10 6", 8 12 pdr, 12 3 pdr.	18	800	12,000	3,500,000
Charlemagne..	French	11,270	385	66	27	16	3	16	3	35	4 11.8", 10 5.5", 6 4", 16 3 pdr.	18	680	14,500	5,500,000
Carnot.......	"	12,000	382	70	27	18	4	15	4	3	2 11.8", 2 11", 8 5.5", 4 6 pdr, 16 3 pdr.	17.5	700	15,000	5,400,000
E. Filiberto...	Italian	9,800	345	69	25	10	4	10	10	4	4 10", 8 6", 8 5", 8 6 pdr.	18	600	13,500	
Wörth.......	German	10,000	355	64	24	15		12	3	3	6 11", 6 4", 4 3.5", 8 6 pdr.	18	700	13,000	3,500,000
Preussen......	"	11,000	377	67	20	12		10		3	4 10", 18 6", 12 3.5", 24 3 pdr.	18	750	13,000	3,530,000
S. Viliky.....	Russian	9,000	341	66	24	16	5	12	5	3	4 12", 6 6", 12 3 pdr.	16	550	9,000	4,000,000
Poltava.......	"	11,000	368	69	26	18	5	10	5	4	4 12", 12 6", 10 3 pdr.	17.5	900	13,000	5,500,000
Indiana	U. S.	10,300	348	69	25	18	5	15	5	4	4 13", 8 8", 4 6", 16 6 pdr.	16	400	9,000	4,500,000
Kearsarge	"	11,500	368	72	26	15	6	17	6	4	4 13", 4 8", 14 5", 16 6 pdr.	16	400	10,000	4,500,000
Proposed	"	11,500	368	72	24	16	6	15	6	4	4 13", 14 6", 16 6 pdr.	16	600	10,000	4,500,000



DIAGRAMS SHOWING GRAPHICALLY THE RELATION OF SIZE OF BATTLE-SHIPS NOW BUILDING.

Caliber.	Rate of fire under service conditions.
10 to 14-inch	1 round in 6 minutes.
8-inch	1 " 3 "
6- "	2.5 rounds 1 minute.
5.5- "	5 " " "
5- "	6.5 " " "
4- "	8.5 " " "
12-pounder	10 " " "
6- "	11 " " "
3- "	12 " " "

It is also well to remember that the weight of the projectiles for the guns is different for similar calibers in different countries, and that the initial velocities also vary for the same size of gun and projectile. Therefore, in compiling the subjoined tables, the same elements have been assumed as pertaining to a given type of gun, no matter what the nationality of the piece, for only in this way can anything like a fair comparison be made. As it is, the results are only approximations, but they are fair to all the guns of all the ships concerned.

The first point to strike one in the above table is the preponderating weight of fire per ton of displacement of the new German ship Preussen, and the equally noticeable inferiority of this in the other German ship, the Wörth. This can be accounted for only on the supposition that the information obtainable of the latter's battery is wrong; probably such is the case. The United States ship Kearsarge stands second in the possession of the highest striking energy per ton of displacement; this fine showing is due entirely to the large battery of 5-inch rapid-firers. The proposed new ships of our navy are in the fourth place, and our Indiana class, because of the marked inferiority in the way of rapid-firers, is not above the middle of the list. There is observed, however, the peculiarity of a primary battery composed of two sizes of large guns,—the 13-inch and the 8-inch. In the Kearsarge type there is the same installment. Other nationalities place in their battle-ships, generally speaking, four guns of large caliber, 10, 11, 12, or 13-inch, supplemented by rapid-fire guns of the larger calibers, 4, 5, or 6-inch; then there is a secondary battery of smaller calibered rapid-fire guns, usually known by the weight of their projectiles, as 3, 6, and 12-pounders. These three types we have, as well as the intermediate caliber (8-inch), between the largest breech-loaders and the large rapid-firers. It is because of carrying these guns that our rapid-firers in the Indiana class have to be reduced in number; hence the weight of metal which can be thrown in a minute of time by all the guns of a ship's battery is measurably small.

Before dismissing the subject of the batteries of battle-ships, it should be stated that the tendency outlined in the armaments of the above ships is to come down from the gigantic guns of 14, 15, and even 16-inch caliber, advocated a few years ago, to guns of 12 and 11-inch; these can pierce the thickest armor, and can be handled by men whenever the machinery ordinarily used for them gives out.

The question of the value of the torpedo is not one requiring much discussion here. No weapon is so little understood; it has never been put to the test, and even in practice its results have in no wise demonstrated its great usefulness. That it is the most powerful engine of destruction is all that can be said of it. In estimating the comparative value of armaments no note has been taken of it.

The matter of armor is next in order. Armor is the defence of the battle-ship. It is, perhaps, sufficient to point out that the efficiency of the defence depends greatly on the arrangement of the armor, and that, until experts can agree upon a comparatively uniform system of distributing the armor, a fair comparison in this respect is impossible. In proof of this, look at the way the armor is distributed on our thirteen typical battle-ships! The very last developments in the way of battle-ships are the Magnificent and the proposed United States ships. On the Magnificent the thickest armor is only nine inches; right beside her in the list is a smaller English ship carrying a maximum thickness of eighteen inches; between these extremes fall the remaining ships under discussion. The manner of distribution is not the same on any two ships,—hence no comparison is possible.

Some of the difficulties in the way of properly deciding which is the best method to adopt in protecting a battle-ship with metal can be understood better by stating in a few words some of the systems followed in armoring the ships given in the table. The Magnificent has a belt of armor of 9 inches' thickness, extending along 216 feet amidships, from about 5 feet below the water-line to as much as 10 feet above it. Thus her whole side, for a portion of her length, is armored. The Royal Sovereign has a partial belt 18 inches thick for a portion of its length; the remainder is diminished gradually to 6 inches at the ends. This belt reaches 4 or 5 feet up from the water-line. Above it comes a side protection of 4 inches. The partial belt of the Renown is but 8 inches; her sides are 6. These examples show the variety existing even in a naval country like Great Britain. France radically differs from every other nation, in that she adheres to a complete water-line belt of armor, from the ram bow all the way to the stern; such a continuous belt is narrower than a partial one, but is quite as thick. In our battle-ships the character of the protection follows more that of the Royal Sovereign class than that of any other type. Generally speaking, the thickest armor on a ship is found on the partial belts and the turrets for the big guns. Some ships carry this same thickness across the ship in the bulkheads, but ordinarily there is here a slight reduction in thickness. The casemates, or small turrets in which the large rapid-fire guns are emplaced, usually have thinner armor than the large turrets.

All armor in use in the ships now building or to be built is face-hardened steel. Various kinds are being manufactured, the processes differing more or less, but all possessing in common the features of a carburization or cementation of one of the surfaces and a chilling of this face of the plate. In the United States and England the Harvey process is employed to accomplish this; we use nickel steel for armor; England claims that she secures as good results with steel alone; there can be no question that the latter metal is the cheaper. The only point to be observed in the application of armor to modern battle-ships is that greater protection is being given to the battery. The water-line armor of the ships in the Chino-Japanese war was but little injured by shot; but the Chinese could not stand up behind their upper-deck guns, for lack of protection to both crew and gun.

The question of the ability of the different thicknesses of armor to stand punishment is not a difficult one to answer. The gun has always been able to keep ahead of the protection. The heavy guns mounted in the ships we are discussing will pierce the heaviest armor any one of them carries. This, of course, presupposes an attack by the gun on the armor under the most favorable conditions for the gun. What will happen in a fair, square, stand-up fight has yet to be determined. Perhaps then the nine-inch sides of the Magnificent will prove worthy of the name of the ship; perhaps, on the other hand, the long narrow thick belt of the Frenchman will win the day. And, it may be that both these French and British ships will go down when they attempt to stand before the combination of their two methods as exemplified in the distribution of the armor on board the Royal Sovereign or the American ships.

When inspecting the motive powers of the typical battle-ships, much must be allowed for. Horse power under forced draft is an unknown quantity, until the theory of the estimate is put to the practical test. Then, too, it must be remembered that from this estimated horse power is deduced an estimated speed, and this estimated speed will, as like as not, be practically demonstrated to be considerably in error. The facts deducible from the tables of horse power and speed are that there is, on the whole, more unanimity of sentiment on this point than on any other connected with our specimen battle-ships. The object of horse power is to produce speed, and all of the above battle-ships seem to be satisfactorily engined when they can be made to go at about 17 knots. The greatest divergence is only three knots,—between the 15 demanded of our Indiana and the 18 of the French ship. Actually our ship has, under rather unfavorable circumstances, done better than 15.5 knots; probably the French ship will not come up to the hoped-for 18. Speed in excess—that is, speed acquired at the expense of some other qualification of efficiency—is not a desideratum in a battle-ship. Ships can fight with a good manœuvring speed of 15 knots quite as well as if that speed were 18 knots, for the ships are to fight, not to run away or even think of doing so. Increased speed means the giving up to engine weight that which otherwise could be put into the weight of the battery or of the armor. Unquestionably a certain speed is needed to get to the place of action, and to stay at that place, but, further than this, speed should have no place of prominence.

The data concerning the coal capacity at normal draft and with full bunkers are not complete. So far as can be seen, all battle-ships carry ordinarily but a limited supply of fuel at normal draft, though this amount varies considerably in the different ships. Coal is a good thing to have on board a ship; it is especially good, when the ship is compelled by force of circumstances to wage war in remote seas. But it is on the reserve bunker capacity that these big ships will have to depend when they arrive on the field of battle.

Coast defence is primarily the object with all maritime nations, and this defence is generally to be preserved by winning battles on the open sea remote from the home littoral. Great Britain's line of home defence, however, is to be as near the enemy's coast as she can get; there is where she proposes to establish her first line of fight.

In concluding this discussion of the salient features of some of the latest developments in battle-ships, one finds himself really no wiser than before he began. As an Englishman is distinct from an American, each fancying himself the superior of the other, so is the Magnificent or the Royal Sovereign different from the Indiana or our proposed ships. Until battle-ship meets battle-ship to fight to the death, there will continue to be big ships built by one country, and bigger ones by another; some full of small guns, others with a preponderance of large guns; some covered from head to foot in complete armor, others distributing it about in spots; some will steam at high speed, while others will be content to follow more leisurely; some will stow thousands of tons of coal, others will carry only hundreds. Perhaps all these differences are of no real importance, for the untried factor which, beyond any disagreement, counts most in enabling a battle-ship to perform her duty best is that same factor which won Trafalgar, and which made a naval history for the United States,—"the man behind the gun."

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Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.*, $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London.
Domestic Engineering. *m.* $2. Chicago.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.

Electrical Review. *w.* 21s. 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6*d.* London.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36s. London.
Engineers' Gazette. *m.* 8s London.
Engineering. *w.* 36s. London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8s. London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technograph. *yr.* 50 cts. Urbana, Ill.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

Chief Bonner's Protest Against Tall Buildings.

CHIEF BONNER, of the New York Fire Department, being an able and intelligent official possessing the confidence of the public, his warning of danger to occupants of tall buildings is likely to make an impression. As reported in *Fire and Water* (Sept. 9), the inherent danger, depending upon the height, is likely to be increased, since the over-reaching arrogance of builders seems rather to grow than to diminish; and the chief is reported as saying that he would not be surprised to see buildings five hundred feet high yet erected.

What possibilities of danger to life exist in the case of a fire in one of these structures is best set forth in Chief Bonner's own language, which is of such import that we quote from it liberally. After admitting that the steel frame-work of the modern tall office-building, when the frame-work is properly covered, is practically proof against all the heat that could be generated by the combustion of its wood-work, wooden fixtures, and furniture, and that, in this sense, such buildings may properly be considered fire-proof, he says:

"There is, however, one danger that must be considered. The outbreak of fire in the offices on one floor would naturally result in the combustion reaching other floors. The fire would follow the steam-heating pipes, and spread in that way. Now, smoke is as dangerous to life as flame is, and, suppose a fire in one of the top stories of one of these tall buildings to have gained some headway, one of the most important things to do would be to reach the roof, and open ventilators to let the smoke escape. It would not be so easy to reach the roof of a twenty-five-story structure, with the elevator service cut off by dense smoke above. The elevator shafts themselves would be a source of danger in case of fire, as they would act simply as flues or conductors for smoke. And, as the stairways in mostly all the tall buildings are constructed close to the elevator shafts, and pass by the latter at every landing, it follows that the stairs would become impassable as well as the shafts. Smoke from fire in lower stories would quickly reach the upper ones in this way, and, as elevators and stairs are the only means of escape from those floors that are above the reach of the department's appliances, the peril of the situation is obvious. In my opinion the tall building should have its stairways constructed as far away from the elevator-shafts as possible. There should be two distinct avenues of escape from the building in case of fire. I have said that the term 'fireproof' may fairly apply in the case of buildings occupied only as offices. But, suppose that the constant increase in the number of sky-scrapers causes a diminution in the number of available tenants who want office-room only? This I think is a very possible result, and it will naturally have the effect of filling many rooms in the buildings with tenants engaged in mercantile pursuits. The owners will rent to such tenants as they can secure. Thus there will be quantities of inflammable materials stored within the walls, and an outbreak of fire more probable and vastly more serious. Some of the big buildings have already given up their ground floors to mercantile business, and the tendency in this direction seems to grow. It is entirely different to have a fire break out among merchandise than to have one in an office, with its few desks and chairs. In the former case a degree of heat may be generated sufficient to reach and warp the steel-cage frame and induce a collapse of the building.

"Buildings exceeding 125 feet in height are beyond the reach of the fire department's best efforts. In our opinion 125 feet is the limit of height consistent with safety. If the sky-scrapers are to continue to soar higher and higher, a law should be passed making it mandatory for the owners to furnish their buildings with first-class machinery for extinguishing fires and to maintain skilled men to operate it. It has been said, and truly enough, that the fire department is paid to protect property from fire. But, as I say, there is a limit to our powers.

"At present there is no law to compel owners of skyscrapers to provide apparatus on their premises. It is only when a modification of the original building plans is applied for that the board of examiners of the building department exacts, as a *quid pro quo*, a stipulation that the building shall be equipped with fire-apparatus. But we do not believe that such stipulations are complied with in the sense in which they are meant, nor can the board of examiners enforce them, as there is no law covering the case. It is merely a question of good faith on the part of the owners. Such appliances as are provided are not, we believe, first-class, nor do they receive any regular care. Besides, they are merely in the charge of the janitor or his staff, who are not trained or skilled in their manipulation. Hence they would prove practically useless in an emergency.

"What the department considers necessary in this connection, in view of the existing and future probable height of 'skyscrapers,' is that a law should be passed containing the following provisions: All present office-buildings, the height of which exceeds 125 feet, should be required to be provided with steam pumps, standpipes, hose, and hose connections. There should be a sufficient pressure of steam up at all hours, day and night, to force the water to the upper floors, and to run at least one elevator car at night. The owners of the building should employ experienced men to work the machinery. These men, who should be continually on duty, would be able to check a fire, pending the arrival of our apparatus. The danger of smoke cutting off the elevator shaft would thus be minimized, and the firemen enabled to ascend quickly to those parts of the building which otherwise would practically be inaccessible.

"The power to insist upon these precautions being observed should be vested in the board of examiners of the building department. The fire department should have in its discretion the approval of the appliances when put in place, and it should also be vested with the right of periodical inspection of them. As long as these precautionary arrangements are lacking in a building above the height I have mentioned, I consider that it constitutes a menace to surrounding property, and that it may justly be regarded in the light of a public nuisance."

The Hennebique System of Cement Arme Construction.

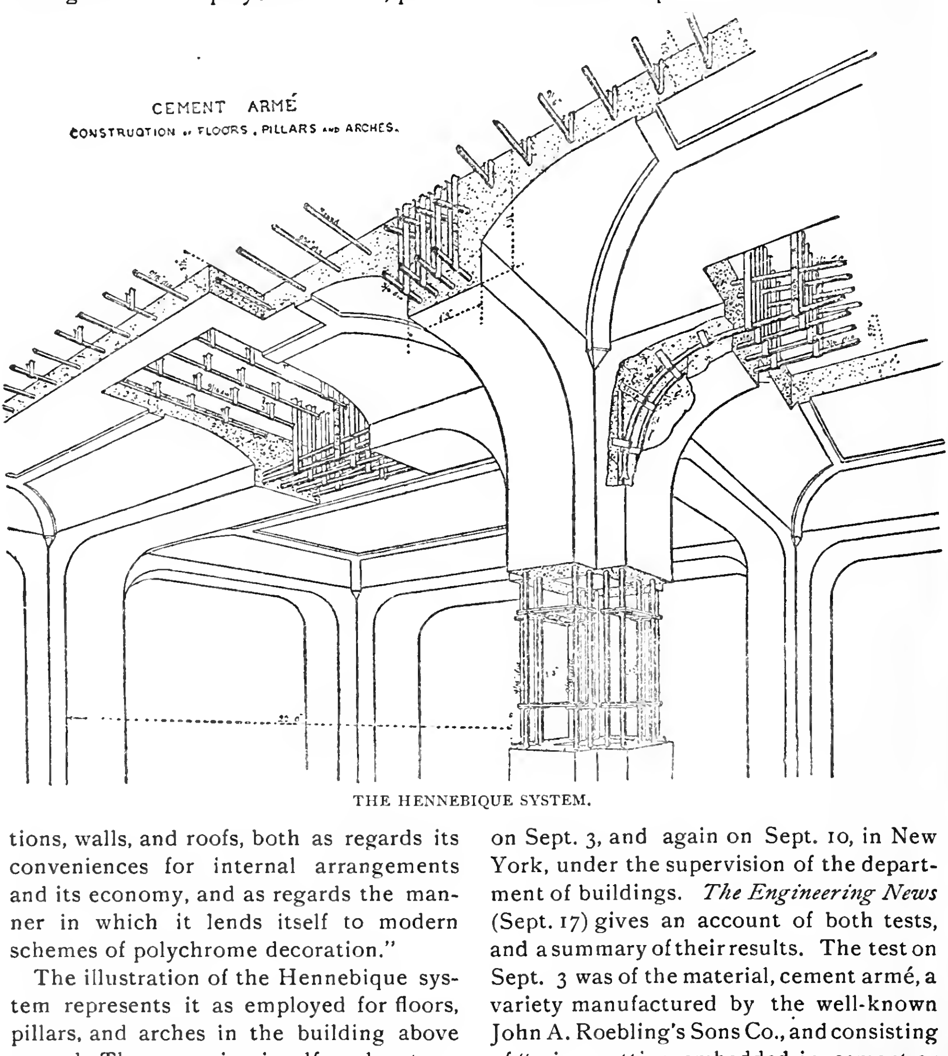
THIS system of construction appears to be meeting with growing favor in France, as a rival to two other prevailing systems of cement armé construction. What is here called cement armé is cement reinforced by imbedded thick wire, trellis, or light bars either of iron or steel. Two of these systems, the Coignet and the Hennebique, are employed in the new building for the Society of Civil Engineers of France, now completed in Rue Blanche in Paris.

In an article on this subject *The Building News* illustrates the Hennebique system, and we herewith reproduce the illustration. Speaking of the use of iron and steel as a building material in France, prior to the present era of cement armé construction, our contemporary says:

"Parisian architects and builders, although far from approving the extremes to which their American *confrères* go in the employment of iron for the construction of their somewhat exaggerated sky-scraping buildings, in which the style of architecture employed is often scarcely logical or consistent with the modern methods of construction, are nevertheless obliged to own to the necessity and the utility of employing iron in moderation for the framework of their buildings. Up to the present the use of iron in its ordinary form has chiefly been confined to floors, partitions, and roofs, where, as a rule, its presence is masked by coverings of cement, wood, or stone, except in recent examples of the new style of buildings destined for *brasseries* or drinking-halls, where the iron construction is left visible, and emphasized by means of bronze or color painting and mosaic work, or, again, in the few examples of well-known work where the architect has endeavored to obtain a decorative effect by means of iron lintels and columns."

It adds to the above that the cement armé has proved its strength and "its advantages when employed for floors, partitions, walls, and roofs, both as regards its conveniences for internal arrangements and its economy, and as regards the manner in which it lends itself to modern schemes of polychrome decoration."

The illustration of the Hennebique system represents it as employed for floors, pillars, and arches in the building above named. The engraving is self-explanatory. The system has hitherto been used chiefly for "industrial purposes in the north of France," and is said to maintain its ground against the other methods of employing cement armé. Its adoption for the new building for the Society of Civil Engineers is strong proof of its merit. One of the conditions under which the contracts were given out was that they should be let to members of the society only, and the architect is also, we believe, a member of the society.



THE HENNEBIQUE SYSTEM.

Tests of Fire-Proof Material.

TESTS of fire-proof materials were made on Sept. 3, and again on Sept. 10, in New York, under the supervision of the department of buildings. *The Engineering News* (Sept. 17) gives an account of both tests, and a summary of their results. The test on Sept. 3 was of the material, cement armé, a variety manufactured by the well-known John A. Roebling's Sons Co., and consisting of "wire netting embedded in cement or concrete, the floors having the netting in the form of an arch between the lower flanges of the floor beams, and sometimes having a flat ceiling composed of a layer of netting attached to the flanges of the beams and covered with cement and plaster."

"A small steel skeleton building was erected on a vacant lot at Eighty-second street and Western Boulevard, having grates for the floor, and having the roof formed of the Roebling arched and flat-ceiling construction, besides which there were two partitions extending from the walls. The fires were lighted at 11:10 a. m., the temperatures inside the structures being recorded by a Uehling & Steinbart pyrometer and ranged as follows:

	Degrees.		Degrees.
11:26 a. m.	1,150	Noon	1,990
11:30 "	1,300	12:01 p. m.	2,000
11:37 "	1,600	12:02 "	2,025
11:42 "	1,800	12:03 "	2,150
11:53 "	1,800	12:04 "	2,100
11:55 "	1,900	12:05½ "	2,125
11:59 "	1,950	12:07 "	2,150

"About 12:45 a detachment from the fire department extinguished the fire, using a single hose, the principal damage done being the falling of plaster from the wire, leaving the netting exposed, though the concrete above it still carried the load of bricks piled upon it before the commencement of the tests. One partition, with a single sheet of netting, had collapsed, and was nearly stripped of its plaster covering; while the other, with two sheets of netting, though distorted and cracked, was still practically a partition. Some of the ceiling plaster fell from the wire during the fire, and some was knocked off by water from the fire hose.

"In another brick building, ten by eleven feet, with half the roof formed on the Roebling system, the other half being ten-inch hollow tiles all set between ten-inch I-beams, a fire was lighted in the same way, and maintained from about 11:07 a. m. to 12:30 p. m., when it was extinguished by the firemen. On each of the floor-arches was a load of bricks of about nine thousand pounds on a space of four by four feet, but neither arch showed signs of collapse, though some of the netting of the Roebling arch was exposed by the falling off of the plaster."

A subsequent examination by the building department failed to detect any measurable deflection of the iron beams of the floors, which were loaded with one hundred and fifty pounds to the square foot. This test for deflection was made with a level-rod. Some of the partitions had buckled through, not having any chance for expansion. "In one case, where no flat ceiling and air space were used, the wire netting was practically destroyed, but the iron and the concrete are considered amply strong to carry any safe load, so that there would be no need to rebuild the floors because of the destruction of the netting. In the other building the Roebling floor is said to have shown no deflection, while the flat floor showed a deflection of about five-eighths of an inch."

It will be noted that the fire and water tests were about as severe as it is possible to contrive, and that the resistant powers of the material are great.

The test on the tenth of the month was of the system of floor construction of the Fawcett Ventilated Fireproof Company, Ltd., of Philadelphia, which also showed a high resisting power. Both these tests (other tests of a similar kind, it is said, are to follow) will be of interest to engineers and architects, as described in greater detail in the article reviewed.

Effects Obtained by Judicious Painting.

"THE once-despised mineral paint is just now, when properly handled, as dangerous a rival as the elegant carved woods have, even in the most modish and extravagant homes." So says Violette Hall in *The Painter's Magazine*. This writer traces the recognition of the possibilities of mineral paint to the commencement of the "antique craze," when "old rush-bottomed chairs were dragged from the attic, the frames painted a clear, brilliant scarlet, and the seats a dead white, making a gay, pretty effect for piazza seats, or for a simple, particularly a somber, sitting-room, though they were never appropriate when used, as they frequently were, in a stately drawing-room, among more pretentious furniture.

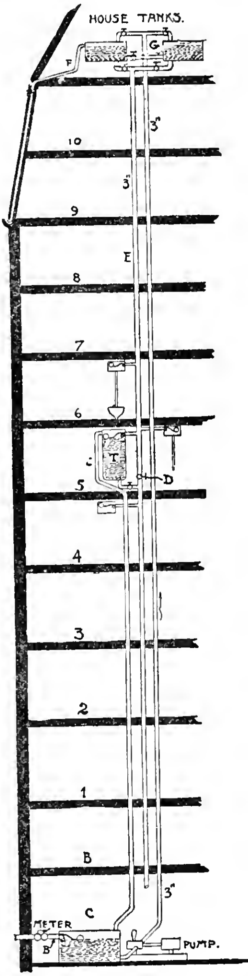
"This bizarre effect of red and white, though not really artistic in itself, has proved useful to the makers of attractive homes, and it disclosed the decorative secrets of mineral paints. Before this era, the impecunious house-furnisher who could not afford the more expensive woods had to resort to the unsatisfactory veneering, or the worse staining, except for the homely bed-room suites known as cottage sets.' These, for some unknown reason, were painted a sort of molasses-candy color, and decorated with bunches of coarse flowers and fruits of the most impossible nature. Later on, these sets took on rather prettier colors, but they were never very ornamental, and have always borne the stamp of rigid economy.

"But, when the clever woman of the family saw how truly pretty the dazzling seat of her red chair was, she very naturally began making other experiments in white paint. She tried it upon her discolored rattan rockers, and also upon certain objectionable stained tables, producing at a small expense really desirable additions to her own and her children's boudoirs. These fresh bits, as a beginning, gradually evolved the snowy-white bed-rooms of present popularity, which now include the painted iron bedstead and the soft wood bureau of quaint design, cheap in the buying, but which, in a coat of white enamel, are pretty enough to satisfy the most esthetic. Nothing could be daintier or more tasteful for the home than this style of furniture, whether it is the lovely Frenchy effects of white and gold of the fashionable drawing-room, or those simpler ones of amateur manufacture which, while less brilliant than the more elaborate affairs of the modish cabinet-makers, make up in a dainty, chaste simplicity something of what they lose in more showy charms."

The use of paint is still further extending. Tea-tables painted a brilliant white, without any other ornamentation, and broad, flat, wooden frames painted a dull silvery green, used for plate-glass mirrors and valuable pictures, are now used in fashionable houses.

Water-Tanks for Tall Buildings.

THE accompanying engraving, reduced from *Domestic Engineering*, illustrates a method of relieving pipes from the undue pressure to which they would be subjected in tall buildings were the water for lower stories drawn from the roof-tanks. Such pipes as are commonly used, or the usual fixtures, would be inadequate to withstand such pressures, and, if extra strong pipes and fixtures were employed, they would very materially increase the cost of the plumbing for such a building. Our cotemporary says: "The illustration is that of a suppositious building of ten stories and attic, with basement and sub-cellar. House tanks are located in the attic, and an intermediate tank on the fifth floor. It will be observed that the house tanks are connected together by a pipe on which there is a shut-off valve. A three-inch main runs from the pump in the sub-cellar, and divides, a branch going to each tank, with a shut-off valve on each branch. The house supply for the upper five stories is taken from these tanks by a three-inch main, with a shut-off valve from each tank. This main also supplies the tank located on the fifth floor, and there is a shut-off valve at D. The supply of water to the intermediate tank is governed by a ball valve, and there is an outlet from the tank, which is governed by a shut-off valve



WATER TANKS IN TALL BUILDINGS.

There is also an overflow pipe from this intermediate tank, C, which leads into the main receiving-tank in the sub-cellar, so that, in case the ball valve in the intermediate tank fails to work, the overflow will be carried into the receiving-tank, and the water will not be wasted. The overflow from the tanks in the upper part of the house is carried into the eaves. Water is supplied to the main receiving-tank in the sub-cellar through a leader, and its flow is governed by a ball valve."

Furniture of Rooms in Relation with Sanitation.

A SUGGESTIVE article by an unnamed writer is quoted and commented on by the *Plumber and Decorator.* In the article quoted are some points with reference to house sanitation that will be new to many readers. The author does not go to extremes in the reforms he proposes, but at the same time he deprecates the loading of rooms with *bric-à-brac* and furniture, and gives what seem sound reasons for condemning excess in furnishing.

"A room loaded with bric-à-brac and clogged with unnecessary furniture is a distinct and continuous burden. It demands constant care to be kept clean, and its confusion adds to the fatigue of a weary brain. Most of all, such a room is an hourly menace to health. It is impossible to reject longer the statements amply verified by experiments concerning the actions of microbes. We know to a certainty that a million or more of lively organisms may be cultivated into prodigious enemies from an amount of dust taken from the top of a dining-room or sleeping-room door that would cling to the point of a pin."

With reference to the multiplication of disease germs in the small amount of dust which might be lifted on the point of a pin, it may be said that the extreme case is used as an illustration of the danger which may lurk in dust accumulations, and as rendering more emphatic the statement that, the more a room contains, the more difficult it is to maintain a high standard of cleanliness in it.

As to curtains at windows the *Plumber and Decorator* reasonably holds that their action as air-filters in restraining dust from entering rooms compensates for their admitted obstruction to light and air. It might well have added that an apartment kept in a subdued light will be comparatively free from house-flies, which are sore pests to all good house-keepers. On the other hand, a darkened room favors the ravages of moths, so that the *pros* about balance the *cons* on the curtain question. As to carpets all sanitarians are agreed that rugs, which can be conveniently taken up and frequently dusted, are preferable. Immunity from dust is much more difficult to secure in apartments that are over-furnished than where a simple style is adopted. Besides, an apartment over-furnished is a too frequent offence to good taste. A drawing-room is not a museum, yet it is frequently made to look like one. If curios are to be displayed, they should be arranged in a collection in cases in a room set apart. The effect of a beautifully-designed mantel-piece and other architectural adornments is often completely spoiled by a profusion of ill-arranged statuary and bric-à-brac. A few things of this sort, tastefully arranged, may often heighten the effect; but anything placed anywhere for the mere purpose of display is out of place, except in a show-room, and there are many houses whose comfort and appearance would be much improved by relegating superfluous articles to the store-room.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

Construction and Design.

8167. New Engine Houses at Hartford, Conn (Brief illustrated description). Fire & Water-Sept. 12. 500 w.

8369. New Methods of Building Construction at Paris. From *The Building News* (Detailed description of the system employed in the construction of the building for the Society of Civil Engineers of France). Sci Am Sup-Sept. 26. 1600 w.

8454. Difficult Foundations of the Siegel-Cooper Building (Brief description of the new building in New York, with special work necessary on some of the piers on the Sixth Ave. front). Eng Rec-Sept. 26. 600 w.

8472. The Design of Protestant Churches (Most of the matter is derived from the "*Kirchenbau des Protestantis*," a book published under the auspices of the Soc. of Berlin Arch'ts. Traces the influences that have affected the Protestant church architecture). Am Arch-Sept. 26. Serial. 1st part. 3500 w.

*8473. The Proposed War Office (Report of a select committee appointed to inquire into the manner in which the sites available for the erection of the new buildings required for government offices may best be appropriated for that purpose). Arch, Lond-Sept. 18. 3500 w.

*8474. Construction of Stables, Cow-Houses and Piggeries. Louis Hanks (Read before the Sanitary Congress. General rules for arrangement, ventilation, floors and drainage, interior fittings, etc). Arch, Lond-Sept. 18. 2400 w.

*8478. Practical Schools of Brick Design. Robert D. Andrews (Outlines a scheme for establishing training schools where experiments in brick masonry may be tried. Illustrations of fine brick work). Br Build-Sept. 2400 w.

*8479. Architects' Troubles with Brickwork. F. E. Kidder (Discusses the more common troubles met with by architects in trying to obtain first-class work). Br Build-Sept. 2000 w.

*8480. Notes on the Design of Brick Buildings. George F. Newton (The importance of training the imagination, with suggestions helpful to students. Illustrations of fine examples of foreign brickwork). Br Build-Sept. 4000 w.

*8481. What Constitutes a Fire-Proof Building Material. Peter B. Wight (Concludes that a true fire-proofing system can only be based on the use of hollow clay blocks for all interior and roof constructions, and the protection of iron and steel). Br Build-Sept. 1800 w.

†8483. The New Great Northern Theatre and Hotel Building, Chicago (Illustrated description). In Arch-Sept. 4000 w.

*8601. The Architecture of Our Large Provincial Towns (The first of a series of articles which propose to review the architecture of the leading towns of Great Britain, giving illustrations with remarks and criticisms. The present article deals with Liverpool). * Builder-Sept. 26. Serial. 1st part. 7000 w.

*8607. Some Optical Refinements in English Mediæval Architecture (The first of a series of articles on the peculiarities in the mediæval architecture of England, tracing in modern architecture also the continuation of standard principles). Arch, Lond-Sept. 25. Serial. 1st part. 2000 w.

8625. The Park Row Building, 30 Stories High: New York City (Illustrated detailed description of the highest building thus far designed in New York city). Eng News-Oct. 8. 3800 w.

Heating and Ventilation

8283. Heating and Ventilating of the Lewis Institute, Chicago, Ill. (Illustrated detailed description). Heat & Ven-Sept. 15. 2200 w.

8284. Heating and Ventilation of the Union Street School Building, Johnstown, Pa. (Illustrated detailed description). Heat & Ven-Sept. 15. 500 w.

8286. A New System of Heating (Illustrated detailed description of a system in which reflection of heat is the underlying principle). Heat & Ven-Sept. 15. 1400 w.

8287. Ventilation of School Buildings (Read before the Am. Inst. of Instruction, Bethlehem, N. H. A general dissertation upon school ventilation, its cost, etc). Heat & Ven-Sept. 15. Serial. 1st part. 3600 w.

8328. A One-Pipe Heating System in a New York Building (Illustrated detailed description of installation in University Building, eleven stories high, and covers an area of 100×177 feet. All floors above the seventh are heated by the one-pipe system). Eng Rec-Sept. 19. 1400 w.

*8446. Warming Auditoriums (Illustrated description of a method whereby, it is claimed, the engineer may control temperature without interfering with the ventilation of an auditorium). Dom Engng-Sept. 900 w.

*8447. A Good Job of Hot-Water Heating (Illustrated description). Dom Engng-Sept. 900 w.

*8448. Heating and Ventilating Residences. James R. Willett (A series of office rules for architects' use in estimating the sizes of furnaces, etc., required to heat buildings). Dom Engng-Sept. Serial. 1st part. 2500 w.

8564. The Mechanical Features of the Siegel-Cooper Department Store (The first part is an illustrated description of the ventilating apparatus in the great Siegel-Cooper store, New York). Eng Rec-Oct. 3. Serial. 1st part. 2000 w.

Landscape Gardening.

8249. The Garden in Autumn (Editorial, and papers from W. Watson, T. D. Hatfield and F. N. Gerard giving suggestions that promise good results). Gar & For-Sept. 16. 4500 w.

8375. A River Parkway (Editorial comment on report recently issued by the Metropolitan Park Commission, and review of the landscape architects, discussing projected improvements in the lower Charles River, in the limits of Greater Boston). Gar & For-Sept. 23. 1300 w.

Plumbing and Gas Fitting.

8280. By-passes of Various Kinds. Grayson (Illustrated description of by-passes that can be used in various situations and for various purposes). San Plumb-Sept. 15. 1200 w.

*8442. The "Lancet" and Sanitary Plumbing (One of the examples of defective sanitary work reported by *The Lancet* (Lond.), and the scheme for remedying defects. Illustrated). Dom Engng-Sept. 2300 w.

*8443. Grease Traps. Reprint from *Home Study* (Illustrated description of a method for intercepting grease and preventing its entrance into drainage pipes). Dom Engng-Sept. 1300 w.

*8444. Fresh Air Inlets (Illustrated description of a number of methods of providing air inlets to running traps on house drains). Dom

Engng-Sept. 400 w.

*8445. A Sample of Criminal Plumbing. C. Desormeaux (An illustrated description of a shamefully botched job). Dom Engng-Sept. 400 w.

8455. Plumbing in Mr. E. C. Benedict's Country House (Illustrated detailed description). Eng Rec-Sept. 26. 1200 w.

8517. The Drainage of Buildings (A paper read before the Sanitary Inspectors' Association, held at Leeds, Eng. A general dissertation setting forth under various heads the essentials to good house drainage). Arch & Build-Oct. 3. 1300 w.

Miscellany.

*8124. An Arraignment of American City Architecture. III. E. C. Gardner (Considering the nature and causes of the indifference to art that prevails in city building). Eng Mag-Oct. 3600 w.

*8147. The Strength of Georgia Pine. Harry H. Miles (Experiments investigating the transverse and compressive strength of pine). So Arch-Sept. 1300 w.

*8148. Monument to Jefferson Davis (Brief illustrated description of accepted design). So Arch-Sept. 600 w.

*8162. Kalsomining, or Water Color Painting. A. Ashmun Kelly (Full directions for securing perfect results). Pl & Dec-Sept. 1100 w.

8188. The Revolving Stage at the Munich Royal Residence and Court Theatre (Illustrated description). Am Arch-Sept. 12. 1200 w.

*8202. The Jews as Builders (Claims that the Jews did not distinguish themselves as builders. Buildings mostly of wood. Refers to legends connected with the building of Solomon's temple). Ill Car & Build-Sept. 4. 1000 w.

8270. Tests of Fireproof Material (Describes tests of the Roebling fireproof construction system for floors and partitions of buildings, made in New York on Sept. 3, under the supervision of the Department of Buildings). Eng News-Sept. 17. 1000 w.

*8319. Ecclesiological Notes from North Germany. T. Francis Bumpus (Part first is an illustrated description of the Cathedral in Münster). Arch, Lond-Sept. 11. Serial. 1st part. 3000 w.

*8320. The Action of Heat on Cement. J. S. Dobie (Read before the Engineering Society of the School of Practical Science, Toronto, Canada. The purpose of the paper is to show what may be expected from a mass of concrete or cement, when subjected to great heat). Arch, Lond-Sept. 11. 2400 w.

*8321. Progress in Sanitary Engineering. Andrew Noble (Address delivered before the Section of Engineering and Architecture, of the Congress of the Sanitary Inst., at Newcastle-on-Tyne. General review of progress). Arch, Lond-Sept. 11. 4500 w.

8326. Conditions for Architectural Competition (Editorial comment on suggestions relating to this matter, recently made in the *British Architect*). Eng Rec-Sept. 19. 800 w.

8339. Puy-en-Velay. M. P. Thompson (Extracts from a paper published in the *Catholic World* for Nov., 1882. An interesting account of a visit to this wonderful town, giving some architectural illustrations and descriptions). Am Arch-Sept. 19. 3300 w.

*8340. Revivals in Architecture (Steps which led to the Renaissance in the fifteenth century, and its progress in different countries). Ill Car & Build-Sept. 11. 1500 w.

†8381. Monastic and Lay Craftsmen of the Middle Ages. G. Baldwin Brown (Notes and comments on the late Anton Springer's treatise, "De Artificibus Monachis et Laicis, Medii Aevi"). Jour of Roy Inst of Brit Archts-Aug. 20. 2200 w.

8397. The Duty of Firemen's Associations to Obtain Legislation That Will Secure Better Protection of Life and Property from Destruction by Fire. Christopher Clark (Changes in construction demanded). Fire & Water-Sept. 26. 900 w.

*8416. Damp in Buildings; Its Prevention and Cure. John McIntosh (Calling attention to some of the necessary precautions against damp to be observed in the erection of buildings, and the remedies applicable in dealing with structures in which damp has made its appearance). Ill Car & Build-Sept. 18. Serial. 1st part. 2000 w.

*8482. The Individual Responsibility of the Contractor. D. B. Garnsey (The importance of considering the conditions existing in the community in connection with individual efforts). Br Build-Sept. 1000 w.

*8518. The Premiated Designs for the Edinburgh Street Reconstruction Scheme (Descriptions by the authors of the premiated designs for the reconstruction of North Bridge Street, as given in their reports accompanying the designs). Brit Arch-Sept. 18. 4500 w.

8522. How Can Better Building Inspection be Secured? (Editorial suggested by a recent collapse of a building under construction in New York city. Outlines a plan for the improvement of the character of buildings). Eng News-Oct. 1. 1400 w.

*8608. Man Before Writing. Prof. Flinders Petrie (A lecture delivered in Liverpool. Deals with the earliest expression of the Greek mind, Greek decorative art, pictures of daily life, ornaments and luxuries of life, early architecture, columnar architecture, figurative mnemonics, and high attainments without recorded words). Arch, Lond-Sept. 25. 4000 w.

8633.—$1.50. Transverse Strength of Spruce Beams, and of Norway Pine Beams (Tabulated data obtained in the laboratory of Massachusetts Institute of Technology). Tech Quar-June-Sept. 200 w.

8635.—$1.50. Compression of Timber Across the Grain (Tests made on the 300,000-lb. Emery testing machine at the laboratory of the Massachusetts Institute of Technology, with results). Tech Quar-June-Sept. 250 w.

8642. The Lofty Buildings of New York City (Illustrated review of the changes wrought by this style of architecture, with some reference to the advantages and disadvantages). Sci Am-Oct. 10. 2000 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Esthetic Movement in Engineering.

The Engineering Magazine, both in its leading articles and its editorial columns, has recently offered several contributions to the discussion of the artistic element in engineering-construction; and that the space is well devoted, and the importance of the topic not over-rated, is immediately apparent upon even a casual survey of current tendencies in the field.

The esthetic conception is, indeed, the one new component in our engineering work. It is hardly conceivable that structural materials or forms will undergo more than a moderate modification or adaptation, though these may be as interesting as the suggestions of Mr. J. B. Robinson in this number of this magazine.

Constructional difficulties are fairly well classified and surmountable by well-known means. Gigantic undertakings have become common-place, and do not differ generically from smaller enterprises, or call for more than proportionate enlargement of common methods. Indeed, the triumphant mastery of natural forces extends so far that the impossible hardly exists, except financially. It is the capitalist, not the engineer, who sets the limit of feasibility.

But the introduction of artistic conception as a controlling influence places the engineer on a new plane; and this has been most admirably pointed out by Mr. F. O. Marvin, in his address before the American Association for the Advancement of Science. After sketching the not unnatural absence of such conceptions from our early work, and the coincident feeling that considerations so "impractical" could not be entertained by the engineer without sacrifice of respect, Mr. Marvin says:

"Time was when he was only the tool of some business man who had money to expend in a certain way, and who employed him, under direction, because of some individual ability. But times are changing. In place of the isolated worker, there is growing up a profession with professional standards and an *esprit de corps*, whose members are to be retained, not hired. Cultured, and with the openness and clearness of mind that only come from deep study, broad training, and large experience, these are to be people of influence whose advice and services are sought, leaders whose judgments are respected, and men who can mingle with the best anywhere on a common ground of attainment and character. The very nature of an engineer's qualifications; his technical knowledge; the cultivation of his judicial and critical faculty; his training in fidelity to the trusts reposed in him by private clients,—all these fit him for places of large responsibility concerned with public works, and the people, tired of political management, are beginning to find this out.

"With an engineering practice based solely on immediate results by way of expected profits in dollars and cents the esthetic element has little to do, though even here its absence may mean financial loss. But, from the standpoint of this paper, engineering is to be considered in the broader light of Tredgold's well-known definition, 'the art of directing the great sources of power in nature for the use and convenience of man,' while the engineer is he who designs and executes engineering works.

"The engineer is primarily a designer. He works with the materials of nature as his medium, and her powers as his tools wherewith to express his thought. . . . Just as in the making of a picture the brushes, paint, and canvas are not the chief things, so here it is not the wood, steel, and brass, or the powers of gravity, steam, air, and electricity, that are most important, but rather the character and quality of the design, and the degree of realization in its execution.

"In a certain sense, then, every engineer is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of 'fine art.' Perhaps, in its true essence, there may be as much fine art in the design of a machine to produce bolts as there is in the making of a picture for the Salon; certainly the well-planned tool, with fine proportions and parts perfectly related, is above the poor canvas.

"From the vantage-ground of his position as a man of educated intelligence and trained ability, the engineer owes the world his best effort. It needs and asks for technical skill and scientific knowledge whereby to-day's work may be done. But also, without knowing exactly what it wants, it feels the need of those added qualities it cannot define, and seeks for guidance and help to something better for to-morrow. In the long run, it will honor the man that meets the demand, and will measure his efficiency on more grounds than that of dollars and cents.

"To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no real antagonism. The result of any act of designing is to be judged as a whole and in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose, and to gratify the observer through its proportions, symmetry, harmony, and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design,—the scientific, the esthetic, and the financial.

"The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design, and an impulse to give expression to it. The effect on the life of our communities and the nation by such a change is not easily estimated.

"We are not an esthetic nation, but we have latent possibilities in that direction; we are young, confident, and impressionable, and have the courage to be original in design, which counts for much. We have evolved the American locomotive, the American truss bridge, the American automatic machine, the American much-debated tall building, and many other things specially adapted to American needs. We shall grasp the artistic possibilities of construction quickly when we come to know what they are, and shall apply them confidently, not always at first with the most happy results. We shall learn some things from the old world, and shall assimilate much that is good in its practice, but in the end engineering here will be both artistic and American."

Extending the principle to machine construction, Mr. Marvin quotes appreciatively from Mr. Albert Williams's article in THE ENGINEERING MAGAZINE for October, 1895. He sketches the indications of the influence, sometimes faultily interpreted, in municipal, railroad, and bridge work; and, coinciding with Mr. Gardner, another ENGINEERING MAGAZINE contributor, he says, regarding bridges particularly: "It is not so much a matter of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers, and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings."

Mr. Marvin applies the principle broadly, even to the laying-out of our cities; recognizing freely the obstacles to improvement which are fixed by financial necessities and established topography, he yet thinks something can be done toward "mitigating the present evils and avoiding any repetition of these in the future. Radical treatment must be resorted to by way of diagonal avenues from congested centers, and the widening-out of the intersections of important streets into parks and plazas. There must likewise be an heroic struggle with the water-fronts and internal watercourses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative, not only by esthetic requirements, but also by the demands of health and business."

This conclusion is strong with hopefulness. He "firmly believes that there is a latent esthetic quality in American life that is now struggling to find both means for its gratification and methods of expression. Before there can be knowledge of its meaning and power, there must be many attempts and many failures. The whole process is one of education, and that largely in the school of experience. This applies to the industrial and constructive arts, as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use, he must do more than keep up, he must keep in advance.

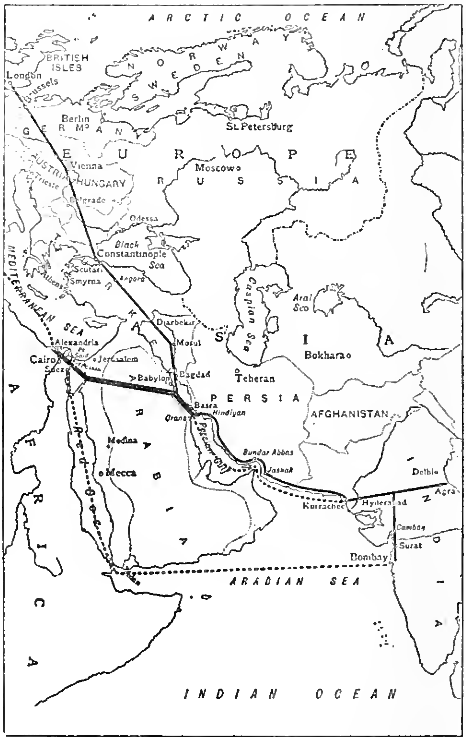
"Yet it should be emphasized that the desired change is not, after all, so far ahead of us. To some extent at least the coming engineer has already arrived, and is making himself felt. The leaven is at work."

An Engineering Project in the East.

THE scheme for "an Egypto-Assyrian Railway as the new overland route to India," sketched by Col. A. T. Fraser in the *Journal of the Society of Arts*, while primarily relating to a piece of railway construction, is too broad in its scope to be classed merely as a railroad item. The development of the project would necessarily involve important bridge, dock, and harbor works; but, beyond that, it would be a factor in Eurasian politics scarcely, if at all, inferior in importance to the Suez canal.

It was so strongly impressed upon Col. Fraser at the time of a "visit to the Persian gulf and Mesopotamia during three months' leave" that he prepared a paper addressed to the Royal Geographical Society; but he was anticipated by Mr. Black's "exhaustive article, 'The Railway to India,'" in the *Contemporary Review*.

Both Mr. Black and Col. Fraser emphasize the point that "the Arabian overland route is . . . an entirely new idea." Heretofore the proposal has always been to extend the line eastward from Alexandretta to Biredjik, at the head of Euphrates navigation, and follow the Euphrates valley thence to the Persian gulf. Alexandretta, however, is infested with malaria, and deeply involved in international complications. The second objection applies with still greater force (from Col. Fraser's point of view) to the very direct rail route which



ROUTE OF PROPOSED EGYPTO-ASSYRIAN RAILWAY.

would be established by throwing a huge bridge across the Bosphorus at Constantinople and prolonging the rails south-eastward across Asia Minor, although this would be the most direct line, and would extend an unbroken railroad system from the English channel to the Persian gulf. Furthermore, "owing to the insistence by the Porte that railroad concessions can only be given to Turkish subjects, great delay is occurring in Syrian lines, while the time-honored necessity of *bakshish*—or greasing of official palms—comes in awkwardly at every step on Turkish soil by which real progress is effected. A Calais-Kurrachee through-train is, after all, a superfluity to a power like Great Britain, with a maritime trade and sea command.

"Laying a railway between Ismailia and the head of the Persian gulf would at once alter the whole complexion of affairs, at a cost of some £5,000,000 sterling, because the steamers already trading to India can do all the remainder of the work. The new overland route could be opened for mails, passengers, and the relief of European troops at the running through of the first Arabian train from Egypt.

"Nor are there any special engineering difficulties to encounter. From Ismailia, after crossing the Suez canal by either a subway or a swing-bridge, there would be a plunge into the winding valleys and sublime desolation of the desert of Sinai; and then the line would make for the head of the Gulf of Akaba, for convenience of access and protection by the British flotilla in the Indian seas. The only at all heavy engineering operations would be in crossing the deep valley above Akaba, which is a continuation of that of the Jordan, and getting upon the tableland of Arabia. Once on that elevation, there is nothing to be expected but the stony desert ring, which Palgrave speaks of, and monotonous undulations of a gravelled surface, with the hollow pass of the Jowf midway, all the rest of the distance down to Bussorah.

"The route across Arabia is consequently the most favorable possible for a railway, crosses an insignificant amount of drainage, and is remarkably clear of settled inhabitants.

"The point to be aimed for in Mesopotamia, as the junction with the Assyrian line from Constantinople is of importance, will, for topographical reasons, be somewhere near Bussorah, where the combined Euphrates and Tigris—known as the Shatt el Arab (or Arab river)— is narrow, and where a bridge must be placed when the line is carried round along the coast of Persia and Beluchistan to Kurrachee. This junction will be so important because it is through it that the supply of coal for the new route, its railways, and its steamers will most likely be derived."

"Branch lines of railway . . . would bring down the trade of southern Persia to its old center at the straits of Ormuz, connecting the port of Bunder-Abbas with Bagdad, *via* Shiraz and Ispahan, and giving Indian travellers a cool alternative route.

"But, returning to the main subject, in order to start the new overland route without any delay, it is necessary to carry the line eighty miles south of Bussorah to the deep-water anchorage of the port of Koweit, and clear of the muddy bar at the mouth of the Shatt el Arab, which is at present impracticable for large steamers. The new route will then have Alexandria at one end and Koweit at the other extremity.

"As fast vessels can make the run down the Persian gulf from Koweit to Kurrachee in less than three days, and it will not take more than a day to cross Arabia by rail, there is an enormous lessening of the time—and, therefore, cost of transit—between the Mediterranean and India. It will only take four days where it now takes ten. The reduction is all the more striking reckoned from Bussorah, whose mails will reach Egypt in one day, that now require nineteen days to get there."

The extremely important political bearings of the project are suggested by Col. Fraser's reference to the "urgent problems demanding solution connected with our temporary occupation of Egypt on the one hand, and the Indian empire, with its nascent home-rule aspirations, on the other. These would be at least greatly simplified if the distance between India and the Mediterranean were reduced to a quick and cheap five days' journey.

"The effect, politically, of the simple and comparatively inexpensive measure of connecting Ismailia and Koweit by railway is nothing short of transferring the commercial frontier of the Indian empire at one sweep from Sind to Alexandria, for it is apparent that only at Alexandria can the harbor facilities, combined with adequate protection, be got for the vast Indian trade the railway would bring. What arrests the frontier on the borders of Sind is, seemingly, the strip 1,000 miles long of stony deserts, to be had almost for the asking, and very nearly ready for the plate-layer to commence his operations."

It is significant that, though the occupation of Egypt is referred to as "temporary," the very basis of the scheme implies the continuous control of Ismailia. And it is but a few days since the foreign dispatches mentioned the khedive's *incognito* visit to France, with the supposed intention of moving toward the termination of British control over Egypt.

In the great game of European politics, statesmanship and engineering enterprise are curiously intertwined.

Tendencies in Engineering Education.

PRESIDENT MERRIMAN'S address before the Society for the Promotion of Engineering Education, delivered at Buffalo last August, has been widely copied and commented upon, and attracts as wide attention in the English engineering papers as it did in the press on this side.

His conclusion summarizes admirably the best modern conceptions of the scope and tendency of a properly-organized course. It supports so strongly certain positions recently taken in these columns that we give Prof. Merriman's last sentences, as follows:

"After four years of work the engineering student receives his degree, and is ready to commence the actual work of life. What the letters are that designate the degree is a matter of small importance. Moreover, if we examine the lists of the alumni who graduated ten or fifteen years ago, the conviction arises that their particular course of engineering study has not been an absolute factor in determining their actual line of engineering work. It is found that graduates in civil engineering are engaged in mining, in machinery, and in electricity, and that graduates in other courses are employed upon work in which they received no especial technical instructions.

"Looking now over the field of tendency thus briefly outlined, it is seen that there has been ever present a powerful impulse towards specialization, to which, indeed, nearly all others have been subordinated. This has demanded a higher standard of admission, great thoroughness in all fundamental subjects, and a rigid adherence to scientific methods. Engineering education has had an active and healthy growth. It now enjoys the respect and confidence of the public, and its future is sure to be more influential than its past. It is not specialization that has caused its success, but rather the methods which specialization has demanded. Those methods have resulted in imparting to students zeal and fidelity, a love of hard work, of veneration for the truths of science, and a consciousness of being able to attack and overcome difficulties; these elements of character are, indeed, the foundation of success in life.

"Looking now forward into the future, it is seen that, in our efforts for the promotion of engineering education, a wide field for work still lies open. The student should enter the engineering college with a broader training and a more mature judgment. The present methods of instruction are to be rendered more thorough and more scientific. In particular, the fundamental subjects of mathematics, physics, and mechanics are to be given a wider scope, while the languages and the humanities are to be so taught as to furnish that broad, general culture needed by every educated man. In general, let it be kept in mind that education is more important than engineering, for the number of men who can follow the active practice of the profession will always be limited. Hence, let it be the object of engineering education to influence the world in those elements of character that the true engineer possesses, so that every graduate may enter upon the duties of life with a spirit of zeal and integrity, with a firm reliance upon scientific laws and methods, and with a courage to do his work so as best to conduce to the highest welfare of his race and his country."

The point to be emphasized and reiterated—so often is it overlooked by hasty students and myopic critics—is that the process of specialization is not one of paring down, but of concentration: it is not one of cutting off all collateral streams, but of gathering them into a single channel.

The student impatient of studies which seem to him indirectly related to his main theme, who discards the broader work for a "special course," as a rule makes a fatal mistake. The special course should be a sequence of the general one; it can never be a substitute for it.

The Failure of Columns Under Eccentric Load.

THE engineering department of the Yorkshire College, Leeds, according to *Engineering*, has been making some interesting tests with a hundred-ton Beckton machine. The one which appears to have the widest importance was of a hollow cast-iron column eleven inches in diameter, one and one-eighth inches thick, and ten feet in length.

Of course a column of such size, centrally loaded, could not be tested to destruction by compression, except by a power at least ten times greater than the maximum limit of this machine; the pressure in the college tests, however, was not applied centrally, but on one edge of a very heavy bracket cast with the column. The piece has, in fact, a massive double-bracketed head, as if designed to stand under a line of floor-beams and receive the ends of beams from both sides; and the load was applied "in exactly the manner in which it was intended to load similar columns in practice," seventeen inches from the center of the column (neglecting the slight deflection due to loading).

Under this application the column failed at 65.5 tons. The break started on the side opposite to that on which the pressure was applied and about a foot below the bracket, in the straight portion of the column. It extended through in an oblique upward direction to the loaded side, just below the fillet at the base of the bracket.

Test-pieces were afterwards cut from the lower part, and showed a tensile strength of 8.45 tons per square inch, and a compressive strength of 30.4 tons per square inch.

The sectional area of the column at the point of fracture was 34.3 square inches, which would give a total compressive strength of over 1,040 tons,—about sixteen times that at which it was actually completely ruptured.

It is at once evident that the column failed, not by compression, but by tension on the side opposite the load, due to bending.

Prof. Goodman is engaged on a series of tests of centrally- and eccentrically-loaded columns, and also of columns with concentric and eccentric cores, but is not yet ready to announce more than the suggestion of results.

In some of these investigations he places special extensometers, reading to $\frac{1}{10000}$ of an inch, on four sides of the column under test. As the eccentric load is first applied, all four show about equal compression; but, as the column bends, the instrument on the convex side indicates diminishing compression, and, ultimately, tension, while that on the concave side shows rapidly-increasing compression.

The results obtained on the single column whose fracture is described indicate, says *Engineering*, "the utter folly of loading columns in this manner,—a practice which, unfortunately, is far too common among architects."

TRANSPORT says: "The Commission which has been inquiring into the proposal to unite New York and Philadelphia by means of a ship canal, has issued its report, and a very valuable and interesting document it is. Two surveys were made under the direction of the commission. By either route vessels would use the Delaware river from Philadelphia to Bordentown. Thence a canal would be cut across New Jersey, entering the sea at Sandy Hook. The distance between the two cities would thus be reduced from 274 miles to 92 miles, of which 31½ miles would represent the canal.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

8173. Erection of a Long Four-Track Draw-bridge (Explains some of the striking featurs of the erection of the trusses and special appliances used in the construction of the bridge over the Harlem River. Illustrations). Eng Rec–Sept. 12. 1500 w.

8268. Hinged Concrete Bridge Across the Danube. O. J. Marstrand (Abstracted from "*Zeitschrift fuer Bauwesen.*" Describes a bridge connecting the village of Inzigkofen with the opposite side of the Danube. The greatest economy was necessary, and the conditions somewhat unusual. Illustrated). Eng News–Sept 17. 1100 w.

*8309. Notes on Weigh-Bridges. Oscar John Kirby (The two varieties of this class of bridge are explained, and the difficulties that are met with, and means of overcoming them are given). Eng, Lond–Sept. 11. 1800 w.

8368. The Rigid Suspension Bridge at Loschwitz, Saxony. Robert Grimshaw (Bridge over the Elbe, just above Dresden, is described and illustrated. The principal innovations introduced are named and described). Sci Am–Sept. 26. 3300 w.

8374. The New East River Bridge (An illustrated account of the new bridge to be built from near the foot of Broadway, Brooklyn, to a point near the foot of Grand St., New York). Ir Age–Sept. 24. 3500 w.

8378.—$1. Suspension Bridges—A Study. George S. Morison (The paper is submitted with a view to opening the way for improvement and to show that a great suspension bridge, which would be well adapted to railroad service, would involve no insurmountable difficulties of construction. A suspension bridge of unusual dimensions and capacity is illustrated and the design explained). Am Soc of Civ Engs–Sept. 16500 w.

8419. The New St. Lawrence Bridge at Montreal (An account of a bridge to be built for railway, street railway and highway traffic, by the Montreal Bridge Co). Eng News–Sept. 24. 800 w.

8423. Diamond Drill Borings for the New East River Bridge Pier Foundations (A description of the plan of work adopted to determine the depth of bed-rock, preliminary to founding the towers of the new East River bridge). Eng News–Sept. 24. 700 w.

*8565. Construction in Earthquake Countries. C. A. W. Pownall (An article intended to supplement a late contribution of John Milne, in further explanation of the destruction of the bridge over the Nagara River in Japan). Engng –Sept. 25. 2000 w.

Canals, Rivers and Harbors.

*8549. The Conditions Necessary for Equality of Velocity in Particles Settling Through Liquids. Luther Wagoner (The object of the discussion is to examine the facts about grains under one millimeter size. Abstract of published results of Prof. Richards are given). Jour of Assn of Engng Soc–Aug. 900 w.

Irrigation.

8269. The Pecos Valley Irrigation System. L. B. Howell (Describes a system having at present 200,000 acres under its operated canals. Gives map, cross-section of lower dam and views). Eng News–Sept. 17. 1500 w.

Miscellany.

8138. Proposed Standard Specifications for Portland Cement (Letters to the editor from S. B. Newberry and Robert W. Lesley, with reply from William J. Donaldson). Eng News–Sept. 10. 900w.

†8205. "A New Method for Determining the Supporting Power of Piles." Franz Kreuter (Explains a new method which the author considers simple and reliable). Ind & East Eng–Aug. 22. 1200 w.

*8288. The Engineering Department of the Yorkshire College, Leeds). Experiments made in the laboratory are described and illustrated. They include tests of cast iron columns, wire rope, hooks, eye-bars, aluminum, and brick arches). Engng-Sept. 11. 2400 w.

†8354. British Highways (Extract from a report prepared by the chief engineering inspector of the local government board). Cons Rept–Sept. 9500 w.

†8356. Manufacture of Portland Cement in Belgium (An account of this extensive and important industry. Ordinary lime, best hydraulic lime, slow setting cement (Portland), and quick setting cement (Roman), are especial products of these immense quarries). Cons Rept–Sept. 3000 w.

8379.—$1. Experiments on the Protection of Steel and Aluminum Exposed to Sea Water. A. H. Sabin (Results of tests on plates with various preservative coatings). Am Soc of Civ Engs–Sept. 3000 w.

8425. Mr. Donaldson's Proposed Standard Specification for Portland Cement. Robert W. Lesley (A letter to the editor in reply to letter of W. J. Donaldson, showing that the latter had incorrectly quoted from a previous communication). Eng News–Sept. 24. 2500 w.

8452. Tests of Sands for Making Mortars (Abstract of a paper by M. R. Feret, chief of the "Laboratorie de Ponts et Chaussées" at Boulogne, prepared from the translation by O. M Carter and E. A. Geiseler). Eng Rec–Sept. 26. 1500 w.

8521. Trestle for Carrying a Flume at Saltville, Va. Emile Low (Description, with illustrated details, of trestle designed for a special purpose). Eng News–Oct. 1. 900 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

Troubles of Electricians at Sea.

As landsmen always like to read about life at sea, they will find a very entertaining as well as instructive sketch of the troubles encountered by electricians on sea-going vessels in *The Electrical Engineer* (London, Sept. 11), in a paper contributed by Mr. E. Craig-Brown. These troubles appear to be wholly unknown to the average central-station electrician on land, or in isolated land plants, whether complicated or otherwise; they arise from causes inherent in the conditions on sea-going vessels, which are widely different from those on land. It is true that the dynamos at sea take their energy from the ship's boilers, but, as Mr. Craig-Brown says, the electrician " must take his steam as he gets it,—*i. e.*, as made for the main engines." And there are, in some instances, breaks in the supply of power to the dynamos, and irregularities, so that it appears to be a fact that a kid-glove engineer from a finely-installed central station " would find himself at sea in more than one sense, if suddenly asked to run the electric-lighting plant of one of our large ocean-going steamers." An example of what he might encounter is set forth in the following quotation:

" *Scene*, engine room of deep-sea steamer; *time*, say, 10.30 P. M. All going sweetly, main engines running well, engineers in good humor. Electric department satisfactory, voltage good, electrician also in good humor. *Group*, consisting of the engineer on watch, the boiler-maker, and the electrician, spinning yarns under the lamp near the starting-gear. Ghost-like 'paneewallahs' flitting about with oilcans and handfuls of waste amongst the plunging rods and levers overhead. Suddenly, in middle of boiler-maker's best story, 'Cri-i-i-n-n-n-n-n-g!!' goes the telegraph, 'stop.' 'Cri-i-i-n-n-n-n-n-g!' again, 'half astern.' A second's pause; then the boiler-maker is running up the ladder with a spanner to stand by that troublesome reversing gear on the h.-p. eccentrics; the engineer is unlocking the levers, and the electrician is replying to the bridge by the telegraph. That done, he rushes to his machines. The 'fourth' has pulled over the levers, and is hanging on to one of them; the little starting engine has begun to work, spitting, knocking, and sticking. A little help to 'the wheel' by hand, and it is flying round, the oil coming off its rim tangentially and going on to the faces of the electrician's friction pulleys. The main engines slow down, and the extra steam thus left in the boilers sends up the pressure. The dynamos whirr, up goes the voltage till the lamps look like melting, and at the same time up goes the electrician's hand to the regulating valve. Too late; what with the sudden increase of speed and the oil from the starting-wheel, the friction is overcome and the pulleys slip. Down go the lights, up goes the smell of burning oil and resin, and the dynamo-engine races as if it would knock itself in pieces. In vain does the electrician apply his best pocket-handkerchief to the pulley faces; the initial friction having been overcome, nothing short of slowing down and the judicious application of powdered chalk to their faces will cause the pulleys to 'grip' again.

" By this time the cause of the sudden stoppage becomes known. [Run into a Chinese fishing fleet off Fu-chow-fu, or something of that sort.] The telegraph signals 'slow a-head,' and the chief engineer is anxious to know 'What's wrang wi' they ——— machines again, as the captain has been speerin' at him aboot the lichts?'

" To continue, 'Does the dynamo not supply the leads with current?' 'Well, yes, in a way. The positive lead gets all that doesn't leak from the brush rocker into the hull of the ship.' You see (unless our electrician is lucky, and has one of these slow-speed drum armatures to manage),the motion of the ship has to overcome a very considerable amount of gyrostatic action in the armature. The bearings, therefore, are subjected to heavy work, and, if they are lined with white metal, he gets rather anxious about them on a rough night,—so anxious that, sooner than see them running out at the end of the spindle from over-heating, he is lavish with the oil. As their temperature still increases, however, he borrows some snow from the refrigerator man, and applies it to the outside of the plummer blocks. It *may* keep the bearings from getting too hot, but it certainly *does* run everywhere when it melts, even over his vulcanite washers, and leakage follows, as a matter of course. Speaking of rough nights, if he is not used to them, he may have occasion to go on deck several times 'to see if there is much phosphorescence in the sea.' During his absence the machines are left more or less to themselves, as the engineer on watch may not be conversant with dynamos."

The three systems of leads in use in marine practice are "(1) the double, (2) single, and (3) concentric. The double leads are on the same principle as those on shore,— *i. e.*, one positive and one negative." Advantages and disadvantages of each system are set forth clearly in a subsequent part of the paper; prefaced by the following remarks:

"The single system is the oldest, as it is the one that would naturally occur to a telegraph electrician. The negative wire is put to 'earth' on the nearest bulkhead. This is better than merely taking the insulating washer out of the negative brush-holder. Similarly, the return wires from each lamp have to go to 'earth.' This, of course, entails much drilling and tapping of ⅜-in. holes in plates for terminal screws.

"The concentric system is used chiefly in the royal navy, and, where expense is not the chief consideration, it is undoubtedly the best. Jointing requires a trifle more skill and patience than in other systems. Making a joint ashore is one thing; at sea, quite another. Picture the electrician trying to stand on a camp-stool in a cramped and dark corner of an alley-way, with a rapidly-cooling solder-bolt in one hand, and a stick of solder in the other. The ship is pitching and rolling; so he has to steady himself by pressing his head against the ceiling. Temperature say ninety-something, and vision imperfect, owing to excessive and continual perspiration. The most angelic temper sometimes gives way in such circumstances."

The double system of leads requires less tapping of plates, has fewer sources of short-circuit and leakage, is less likely to affect the ship's compass, and reduces to a minimum the danger of shock to passengers. On the other hand, it requires more drilling of plates and costs more to install; its chances of rupture, by straining of the ship, and of corrosion, are greater than with the other systems; more time and trouble are exacted in repairs; it occupies more space on account of the double casing, necessitates double cut-out fuses, and is not impervious to dampness.

The single system is simple and cheap to install, and needs only a single-casing; its repairs are simple, and its faults easily located; and it requires fewer and simpler cut-out fuses. *Per contra*, it requires tapping for earths, there is danger of shock from faulty and damp switches, there are chances of short-circuit and leakage along the leads, ship's compasses are liable to be affected by it, and, like the double leads, it is not impervious to dampness.

The concentric system requires casing only where there is a chance of rough usage; it is economical of space, and less unsightly than other systems; it reduces to a minimum the liability of short circuits and leakages, is less likely to affect the compass, possesses the least liability of shock, and is impervious to damp. Its first cost is greater, it requires greater skill for repairs, and it is liable to damage by indentation.

Other interesting points are dealt with, but this review must close here with the remark that Mr. Brown has written one of the best practical papers of the month.

Damage to Underground Pipes by Electrolysis.

It is probably true that nearly all evils are accompanied by some good, and that all that helps mankind to desirable ends is attended with some evil as part of a price paid for progress. The application of electricity to street railroads is an instance in point. If a popular vote could be taken, there would be found an overwhelming majority against a return to previous methods of moving street-cars, notwithstanding the loss of life and injury to persons chargeable to the system, and the fact that it has entailed trouble and danger to municipalities through electrolytic action upon underground water- and gas-mains. These evils being admitted, the question of retaining a great good, with well-directed attempts towards mitigating the attendant evils, would be decided affirmatively by the great majority of intelligent people.

Popular attention has been much directed to the accounts of death and mutilation by the trolley service, of which the sensational daily press has made the most it could. Few have stopped to think that, in proportion to the number of people transported, the accidents resulting from this mode of transportation are less in number than those resulting from riding in carriages drawn by horses; yet it may confidently be asserted that such is the fact, and that travel by trolley is safer than travel by horses and carriages. Those who have studied the subject believe that, as time goes on, the proportion of casualties to the number of those who ride in trolley cars will become less, till a minimum is reached.

So much for the danger above ground. Below the surface another evil has been at work, and forcing itself upon the public attention. This is set forth in a summary made from a pamphlet issued by the electrical bureau of the National Board of Fire Underwriters, and printed in *Progressive Age* (Oct. 1).

"Underground water-mains have broken down because of faults unquestionably due to electrolytic action, and smaller service-pipes have been weakened to such an extent as to break at critical moments, when excess pressure is put upon them at intervals during a fire. Measurements show that conditions unquestionably exist in nearly every district in the United States covered by a trolley road, which are favorable for destructive action on the subterranean metal work in the vicinity; and pipes taken up in many of these districts show unmistakable signs of harmful effects. The general nature of this action and the causes which bring it about are too often seen to need elaborate description. Briefly, it may be compared to the action which takes place in an electroplating bath. The current which enters the bath through the nickel or silver metal suspended therein, flowing through the bath and out through the object to be plated, ultimately brings about the destruction of the suspended piece of metal. Similarly, the current from a grounded trolley system, flowing through the earth in its course from the cars back to the generating-station, selects the path of least resistance, which is generally for a whole or part of the way the underground water-mains, and, at points where it leaves the pipes to reach the station, the iron of the pipe wastes away, until at points the walls become too thin to withstand the pressure of the water, and a break-down ensues. The difference of potential necessary to bring about this action is very small,—a fraction of a volt,—and consequently, in all districts where potential differences are found between water-pipes and the surrounding earth, such actions can be assumed to be taking place, for dampness and the salts necessary to produce electrolysis are present in all common soils.

"Whenever, then, a reading is shown by an ordinary portable volt meter registering tenths of a volt, with the positive binding post in electrical connection with a water-pipe or hydrant and the negative binding post in electrical connection with an adjacent lamp-post, car-track, or metal rod driven in the earth, electrolytic action will be found, upon examination, to be taking place at that point, which will ultimately result in the destruction of the water-pipe. The only certain remedies for this evil are obviously to keep the current from using the pipes as a conductor, or keep it from flowing through the pipes to the surrounding soil. The first remedy necessitates a complete metallic circuit for the railway, and the second a joining of pipes by wires wherever potential differences are found. Trolley roads having absolutely no ground-connections will not be installed as long as the present trend of practice prevails, and consequently an absolute complete metallic circuit for such roads cannot be secured. Bonding all underground pipes together with wires of sufficient carrying capacity to prevent current-flow through the earth would also be obviously impossible. By judicious employment of part of each remedy, however, it has been demonstrated that the evil can be so largely reduced as to be practically negligible, and it is to securing these improvements in the numerous trolley districts of the country that the energies of every one interested should be devoted."

Here we have the evil, the method by which it may be locally detected, and its cure, all clearly stated. We have also the information that the existence of this action upon pipes is not exceptional, but that in nearly all instances where the trolley system has been installed pipes are suffering injury. Why, then, is the known remedy not vigorously applied? There is scarcely any class of investments that yields a better return than the trolley street railroads. They can well afford, and should be compelled, to prevent all preventable damage from the operation of their lines. The public danger lurks, not in the inherent tendency of the lines to induce electrolysis of underground pipes, but in the inherent weakness and corruption of municipal government, that obstruct the enforcement of the duties and obligations which the street-railway corporations owe to the public.

Insurance of Electrical Plants.

THE fire hazard of electrical plants is a topic of interest to all in any way concerned in the use or management of electricity for generating light or transmitting power. In its relations to fire insurance, the subject was brought before the North Western Electrical Association in a paper by Mr. R. H. Pierce (*American Gas Light Journal*, Sept. 21). A statement of the results of a central-station fire is made, among them being the loss of insurance when it can be proved that the rules and requirements of the National Board of Fire Underwriters have not been observed. In such a case there will be added to the loss by interruption of service the loss of the plant. An intimation is made that strict examination would reveal the fact that some existing plants are not insurable, and that, where this is the case, the central-station manager is answerable for the defects. Mr. Pierce says:

"A large proportion of existing plants were installed at a time when the electrical manufacturers and electrical constructors did not understand what materials and methods should be used in order to secure safety; and finally, and worst of all, many plants have been installed by companies or individuals whose only thought was to get the largest price for the cheapest installation, leaving the unfortunate station owners and managers to wrestle with the question of safety, as well as of reliability and economy. But, however serious the question may be, it must be met, and, if attacked in the right way, the solution may not be as difficult as it at first appears."

For the safety and reliability of central-station property proper "care, protection, and attendance" are needed. The rules of the National Board of Fire Underwriters are approved as a guide to the needed appliances and constructions for safety.

The author decidedly favors insurance in responsible companies rather than formation of mutual companies for central-station owners; of the latter he says:

"The plan of forming a central-station owners' mutual company has been 'weighed in the balance and found wanting.' Theoretically, it may be possible to form such a company, but it would be an additional burden to the central-station business, which, I take it, has trouble and problems enough to face already. If fire insurance is a legitimate business,—and it appears to be as legitimate a business as electric lighting,—then we may as well assume that the insurance people know their business, and that the competition between insurance companies will produce as low a rate as could (with equal protection) be given by a mutual company."

There exists a third plan,—"securing maximum safety and then taking the chances." Mr. Pierce thinks that in very special cases only is this the best plan. "If the central-station plant is so designed, installed, and operated as to reduce the fire hazard to a minimum, insurance companies will ask a minimum rate of insurance, which, in most cases, will be so small as to be no burden to the owners. Discarding, then, the two plans just mentioned, we are brought to the first plan of insurance in reliable companies. Accepting this as our line of action, the problem now is to so install and operate our plants that the hazard is reduced to a minimum, or at least to a point where further improvements would increase the cost out of proportion to the additional safety secured. . . . Competition in the electrical manufacturing and construction business has not led to increased safety. On the contrary, it has led to cheapness in both appliances and methods, and cheapness does not mean safety. On the other hand, we must not think that we must be extravagant in order to have safety. The use of proper methods of construction and of intelligence and care in operation is what is most necessary to secure safety."

Of the thirty-four causes enumerated by the underwriters which may, when all exist, raise the premium to over ten dollars per hundred, the following are named as representing more than half the amount,—to wit, improper arrangement of stack, defective wiring, improper construction of switchboard, improper construction and placing of rheostats, storage of oils, gasoline, etc., in station, and improper storage of ashes. One or more of these faults exist in many central stations.

The Denayrouse Lamp.

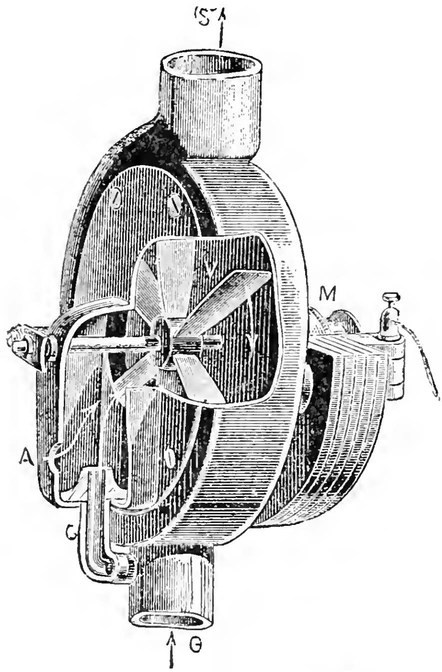
THE Welsbach incandescent gas-lamp has proved a formidable competitor to electric lighting, and the question of the final commercial triumph between gas and electricity for illumination has much occupied the space of papers devoted respectively to the interests of gas and electric industries. The answer seems perhaps likely to be somewhat further deferred by the advent of the lamp herewith illus-

THE DENAYROUSE LAMP.

trated and described, in which the use of mechanical draft in connection with gas and an incandescent mantle has produced results which are, to say the least, astonishing, if reports about them are to be trusted. The description is condensed and the engravings reproduced from *L'Illustration*, a translation of whose article is reprinted in *Scientific American Supplement* (Sept. 26).

This lamp causes the gas to burn in four and four-tenths its volume of air, five and five-tenths its volume being the theoretical quantity stated as necessary to such combustion of illuminating gas as will give it its highest illuminating power when burned in air. It is scarcely necessary to say that the theoretical proportion is not nearly maintained, either with the ordinary open gas-burners or generally with the argand burner.

The engravings are (*a*) a view of the Denayrouse lamp as it appears in operation, and (*b*) a sectional view of the mechanical draft appliance, in which the



SECTION OF THE LAMP.

entrance for air is shown at A, and the entrance for gas at G, and in which V represents the mixer and M the electric motor.

"The apparatus consists essentially of a bronze or brass box in which revolves a fan keyed upon an axle that passes through the box. The axle is revolved by means of a small electro-magnetic machine mounted upon one of the external sides of the box. The motor may also be a hydraulic or compressed-air one. Upon the axle is arranged a speed-regulator. The air enters at the bottom of the box and the gas at the center. The exit of the mixture takes place through a chimney arranged at the top and to which is fixed a luminous mantle. The apparatus operates as follows: The motor causes the fan to make about 1,200 revolutions a minute. There is thus formed a strong draught of air, which mixes with the gas that enters at the side. The ignition occurs at the upper aperture of the chimney."

Such is the simple description of a very simple arrangement. A comparison of cost makes the cost of the Denayrouse light only half a centime per carcel-hour more than that of the ordinary butterfly gas-burner.

The intensity of its light adapts it particularly to the illumination of public places,—parks, gardens, squares, etc.,—and disqualifies it for ordinary interior lighting. The requirement of a motor for each lamp will also add another disqualification for its general use in interior lighting. Exterior illumination appears to be the field for the new invention, if it can be called new. Lamps supplied with air by clock-work motors were invented years ago, and the mere substitution of one kind of motor for another can hardly be called a new invention. The combination of parts with the previously-invented mantel, whose incandescence intensifies the illumination, may possibly form the basis of a valid claim; but even this seems doubtful.

The intensity of the light seems to adapt it in many situations for light-houses. Should it prove that no royalty can be exacted under patents for the use of this lamp, it is likely to come into a somewhat extended use for special purposes to which it is adapted.

Electricity in the United States.

In a serial paper contributed to *The Electrical Engineer* (commencing Sept. 23), Lieutenant B. A. Fiske, U. S. N., starts out with a statement, taken from the journal named, that careful investigation shows the capital invested in the various electrical arts to be no less than $1,500,000,000. This sum almost staggers belief, but it is probably no overestimate. Its very magnitude indicates the enormous extent to which electricity now lends its aid to the other natural forces previously brought under human control. One can scarcely enter an industrial establishment of any importance, a public building, or a private residence having any pretence of comfort or luxury, without meeting with familiar or unfamiliar electrical appliances. A peculiar feature of this pervasiveness is the extent to which electricity has been made to contest the field with mechanical appliances. This is alluded to in a review of Lieutenant Fiske's paper in our department of Marine Engineering; but this contest is not confined to marine appliances; it is actively waged on land. One of the battles apparently won by electricity is its successful application to the transmission of power in machine-shops and manufacturing establishments. Belts and shafting have been replaced by it in many large works, and its use for this purpose is steadily growing in favor. In our opinion compressed air, though it has found a place which it will probably hold among methods of power transmission, can never be made so universally serviceable and practicable as electricity for this purpose. But the contest is extending to other mechanical constructions. Motions that once required ingenious and complicated mechanical movements are now effected by the simple magnetization and demagnetization of electro-magnets. Hand-worked machines have moulted their hand-cranks, and small electric motors have been substituted. Clutches whose operation formerly required a lever and clutch-fork are now made to engage by the pressure of a button, or the movement of a minute switch. Electric regulation of clocks, of throttle-valves, and of many other appliances is now common. It is impossible to see where all this will stop. Probably electricity will continue to invade fields wherein mechanical construction has hitherto been wholly relied upon, and other mechanical movements will, in their turn, be supplanted.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

8146. Electricity at Neuchatel, Switzerland (Illustrated description of plant). W Elec–Sept. 12. 1800 w.

*8186. Connecting Incandescence Lamps in Series on Alternating Currents. E. B. in *L'Industrie Electrique* (A study of incandescence lamps, their connection in series on reaction coils and on little individual transformers). Elec Rev, Lond–Sept. 4. Serial. 1st part. 1300 w.

†8210. The Electric Lighting of Calcutta: Messrs. Kilburn and Co.'s Project (Discusses unfavorably the proposed low-tension scheme of Messrs. Kilburn and Co). Ind Engng–Aug. 15. 2000 w.

8257. Care and Management of Electric Motor-Meters. Thomas Duncan (Remarks and hints on their management, calling attention to the requirements necessary for the successful installing of meters). Am Elect'n–Sept. 3500 w.

8329. Dr. H. Lux on the Lighting of Berlin (Review of a book which presents an excellent survey of the present position of gas manufacture, and of the supply of electrical energy throughout Germany). Am Gas Lgt Jour–Sept. 21. 1700 w.

8330. Test of an Isolated Electric Lighting Plant. S. A. Beyland, in the *Scientific Magazine* of the Univ. of Tenn. (The results of tests of the gas-engine and lighting plant belonging to the First Methodist Episcopal Church of Knoxville, Tenn). Am Gas Lgt Jour–Sept. 21. 600 w.

*8336. Notes on Electric Light in Sea-Going Vessels. E. Craig-Brown (The great difference between practices on sea and land. The difficulties and disadvantages of certain systems). Elec Eng, Lond–Sept. 11. 2200 w.

*8337. Proposed Scheme for Electric Lighting of Aberdeen Harbor (Abstract of report as published in the *Aberdeen Journal*. Description with estimate of cost). Elec Eng, Lond–Sept. 11. 800 w.

*8338. Installations with Incandescence Lamps at High Voltage (Discusses whether it is preferable to use lamps of 100 volts with an efficiency of 2½ watts per candle-power, or lamps which absorb 4 watts with a tension of 220 volts). Elec Rev, Lond–Sept. 11. 1200 w.

8386. Electrical Energy at Toulouse (Illustrated description of system). W Elec–Sept. 26. 1200 w.

*8413. The Lighting of the Great Eastern Railway Company's Stations (Illustrated description of system adopted). Elec Rev, Lond–Sept. 18. 500 w.

8502. Electric Lighting in Nemotown.

Harry N. Gardner (Brief description). Elec Eng-Sept. 30. 2500 w.

8503. The Spectrum of Reflection and the Efficient Illumination of Confined Space. Dr. W. H. Birchmore (A study of spectra to determine why our lamps seem to make darkness visible rather than the objects in it). Elec Eng-Sept. 30. Serial. 1st part. 2500 w.

†8587. A New System of Series Arc Lighting. Thomas Spencer (An illustrated description of a system devised by Mr. William Smith Horry, called his "Reactive System" of arc lighting). Jour Fr Inst-Oct. 1500 w.

*8602. Electric Glow Lamp Tests. William Henry Preece (Experiments to determine an expeditious and reliable way of testing the efficiency and durability of glow lamps. Supplement of curves referred to, and full description. Read before the Brit. Assn. for the Advancement of Science). Elec Rev, Lond-Sept. 25. 2000 w.

*8605. Street-Lighting by Electric Incandescent Lamps. William George Walker (Read before the British Assn. Remarks on this subject with examples where they have worked satisfactorily). Elec Eng, Lond-Sept. 25. 1800 w.

8620. The Design of Large Arc Dynamos. George Albers (Describes a complex commutator as an accompaniment to a type of machine which is given as an example of the extreme practical limit of subdivision of units for a large station). Elec Eng-Oct. 7. 2200 w.

8626. The Cheapest Electric Lighting Plant in the World (Illustrated description of the plant in Johnson, Vt., a village of only about 600 inhabitants. Figures of cost and full particulars are given). Eng News-Oct 8. 4500 w.

8628. Fashions in Arc Lamps and Supports (Illustrations of numerous designs and methods of suspending lamps, that have been in vogue at different periods and in different places, with brief descriptions). W Elec-Oct 10. 800 w.

Power.

*8125. Gas versus Electricity for Power Transmission. Nelson W. Perry (Analyzing the disadvantages that attend local transmission by electricity). Serial. 1st part. Eng Mag-Oct. 4900 w.

8132. Memoranda on Tests of a 300 H. P. De Laval Steam Turbine (Test at 12th St. Station of Edison Illuminating Company of New York. Tabulated statement, with editorial). Elec-Sept. 9. 2000 w.

8133. Ventilating Electrical Subways (Editorial presenting the difficulties of the problem and suggesting the substitution of exhaust for forced draught). Elec-Sept. 9. 700 w.

8134. On Rotary Currents with Reduced Speed. Hans Gorges (Paper read before the Verbandes Deutscher Elektrotechniker, Berlin. Translated from *Elektrotechnische Zeitschrift.* Phenomenon described and attention called to the more important points of the investigation). Elec-Sept. 9. 1000 w.

8141. Electrical Equipment of the New England Building in Cleveland (Brief illustrated description). Elec Wld-Sept. 12. 800 w.

*8171. The Folsom-Sacramento Electric Power Transmission Plant (Brief description, with illustration of the 24-pole three-phase machines). Eng, Lond-Sept. 4. 900 w.

8208. The Big Creek Power Transmission (Illustrated description). Jour of Elec-July. 1200 w.

8211. The Electrically Driven Mills of the Pelzer Manufacturing Co., Pelzer, N. C. (Illustrated description with the advantages incident to the driving by electricity). Elec Eng-Sept. 16. 1600 w.

8212. Extension of the Niagara Power House. Orrin E. Dunlap (Views and drawings illustrate the scene of the wheel-pit and power house extension, and make clear the changes to be made). Elec Eng-Sept. 16. 1100 w.

8258. Commutator Brushes for Dynamo-Electric Machines; Their Selection, Their Proper Contact Area and Their Best Tension. Alfred E. Wiener (Complete consideration from the practical standpoint of the subjects treated. Gives formulas by means of which the cross-sections of brushes and commutator pressure may be simply calculated for any given condition, the results being expressed in square inches and pounds). Am Elect'n-Sept. 2500 w.

8259. Speed Regulation of Induction Motors. P. M. Heldt (The writer shows that the speed of such motors may be varied through wide limits. A number of methods are described for producing variation of speed). Am Elect'n-Sept. 1500 w.

*8323. Electrical Works in Switzerland—The Val de Travers Station. J. E. Petavel (Illustrated description). Elect'n-Sept. 11. 800 w.

8331. Experiments with a Differential Wattmeter. A. B. Reynders, in the *Scientific Magazine*, of the Univ. of Tenn. The making of a differential wattmeter is described and the method of using it). Am Gas Lgt Jour-Sept. 21. 1200 w.

8362. Series Reversing Motor and the Switch and Wiring Connections Used Therewith. William Baxter, Jr. (Explains the series type of motor, and the operation of the switch). Am Mach-Sept. 24. 1700 w.

8363. Additional Tests of Power Absorbed by Electrically-driven Machine Tools at the Baldwin Locomotive Works (Tests made by C. W. Pike, including three-spindle drilling machine, two-spindle drilling machine, radial drilling machine, vertical boring and turning mill, lathe, planers, slotting machine, double-head locomotive frame-slotting machine, double-head frame-slotting machine, and shaping machine). Am Mach-Sept. 24. 1000 w.

8388. Measurement of Power in Two and Three Phase Circuits by Means of Wattmeters. Dugald C. Jackson (A résumé of the various ways in which wattmeters may be applied to the measurement of the power in polyphase circuits). Elec Wld-Sept. 26. 1300 w.

*8412. Electricity Down a Coal Mine (Illustrated description of the method of coal haulage in the Abercanaid colliery, Merthyr Tydvil, Wales). Elec Rev, Lond-Sept. 18. 1400 w.

8499. Shunt-Wound Reversing Motor, and the Switch and Wiring Connections Used Therewith. William Baxter, Jr. (Changes in the reversing switch from the one used in the series machine. Explanation and diagram). Am Mach -Oct. 1. 1000 w.

8524. The Water Power and Electric Transmission Plant of the Big Cottonwood Power Co. W. P. Hardesty (Illustrated detailed description). Eng News-Oct. 1. 4800 w.

8534. German and French Accumulators (Illustrated description of two special forms of accumulators that are attracting attention abroad —The Boese and the "shuttle"). W Elec-Oct. 3. 1200 w.

8539. Electrical Apparatus of the Fort Wayne Electric Corporation (Illustrated description). Elec Wld-Oct. 3. 4000 w.

8551. A Few Pointers for Purchasers of Electric Machinery. William Baxter, Jr. (Discusses the most important points that determine the merits of a machine). Power-Oct. 2500 w.

8562. New Weave Shed and a Two-Phase Electric-Power System for the Grosvenordale Mills (Illustrated description of a weave shed which is a departure from the ordinary practice, and of the additional electric power installed). Eng Rec-Oct. 3. 1000 w.

*8606. Notes on Electric Cranes. E. W. Anderson (Read before the British Assn. Experience that the writer has had with electric cranes in practical use in the Erith Iron works. Considers the system the very best method that has yet been devised). Elec Eng, Lond-Sept. 25. 5000 w.

8621. Present Status of the Distribution and Transmission of Electrical Energy. Dr. Louis Duncan (The writer purposes to take up the different methods of transmission and distribution and to consider the limits that are actually fixed by the present status of electrical development. Part first deals with generating plants and electrical distribution. Presidential inaugural address read before the Am. Inst. of Elec. Engs. Abstract). Elec Eng-Oct. 7. Serial. 1st part. 3000 w.

8641. Electrical Tests of Power Required by Metal-Working Machinery at the Navy Yard, Washington, D. C. O. G. Dodge (Tests of vertical boring machines and planing machines). Am Mach-Oct. 8. 900 w.

8647. Electrical Machinery of the Walker Company (Illustrated description). Elec Wld-Oct. 10. 2000 w.

Telephony and Telegraphy.

8142. An Arrangement for Counting the Conversations of Telephone Subscribers. Jul. H. West (A brief description of a device by which a conversation is counted to the two subscribers using the instruments and the cost divided between them). Elec Wld-Sept. 12. 700 w.

*8187. International Telegraph Conference at Buda Pesth. Translated from the *Journal Télégraphique*. An account of the work done during six plenary meetings). Elec Rev, Lond-Sept. 4. Serial. 1st part. 1800 w.

8209. Thermostatic Fire Alarm Telegraphs. George Herbert Stockbridge (The reliability of the service rendered by this automatic system since recent improvements). Jour of Elec-July. 3000 w.

8315. The Telephone in Railway Operation (An illustrated description of the telephone as used by the extensive system of the Metropolitan West Side Elevated Railway Co., of Chicago). W Elec-Sept. 19. 1800 w.

*8324. The Telegraph in the Ashanti Expedition (1895-6). (Particulars culled from official sources, with regard to the construction, maintenance and method of working of the telegraph during the recent Ashanti Expedition). Elect'n-Sept. 11. 1800 w.

8384. The Telephotic Problem.—A Proposed Solution. Dr. Ernst Huber (An addition to the study of sending light vibrations over a wire. In the method described the Röntgen ray is introduced as an auxiliary at the receiving end). Elec Eng-Sept. 23. 1500 w.

*8504. A Telegraph Cable Attacked by White Ants. E. L. Bouvier, in the *Comptes Rendus* (Account of a cable from Haiphong (Cochin China) which had been eaten away by these insects). Elect'n-Sept. 18. 750 w.

8535. Ingenious Cable Codes. From the *N. Y. Tribune* (Some of the difficulties met with in the use of codes, and information regarding them). W Elec-Oct. 3. 1000 w.

*8604. Electrical Disturbances in Submarine Cables. W. H. Preece (Read before the British Assn. A study of the causes of disturbance and a discussion of the best form of cable). Elec Eng, Lond-Sept. 25. 2500 w.

8614. Improvement in Dynamo-Telegraphy. F. P. Medina (Illustrated description of plant installed by the Pacific Postal Telegraph Co., in San Francisco). Jour of Elec-Aug. 2300 w.

8615. Submarine Telephone Work in New York Bay (Brief account of the recent connection of quarantine islands with the mainland, with map showing route taken). Elec Rev-Oct. 7. 500 w.

8616. History of the Telegraph in Belgium. V. B. (Brief account of the progress of the telegraph in this country, which has just celebrated the 50th anniversary of its introduction). Elec Rev-Oct. 7. 600 w.

Miscellany.

*8130. The Possible and the Impossible in Electric Development. Wm. Baxter, Jr. (Showing how much and how little it is reasonable to expect from electricity as a source of light, heat, and power). Eng Mag-Oct. 2800 w.

8139. On the Seat of Electro-dynamic Force in Ironclad Armatures. William Baxter, Jr. (Objections to conclusions reached by Messrs. Houston and Kennelly). Elec Wld-Sept. 12. 1200 w.

8140. Magnetic Units (Complete report, presented by Prof. Hospitalier before the Geneva Electrical Congress). Elec Wld-Sept. 12. 1600 w.

8145. Manufacture of Potash by Electrolysis.

Orrin E. Dunlap (Illustrated description of process and plant at Niagara Falls). W Elec-Sept. 12. 1500 w.

*8184. The Magnetization and Hysteresis of Certain Kinds of Iron and Steel. H. Du Bois and E. Taylor Jones (Results of investigations, with explanation of process for the construction of permanent magnets). Elect'n-Sept. 4. 2800 w.

*8185. The Part Played by the Dielectric in the Discharge of Röntgen Rays. Jean Perrin (From the *Comptes Rendus*. Describes experiment which justifies conclusions stated). Elect'n-Sept. 4. 800 w.

8239. An Induction Coil. J. B. Hall (The construction of an induction coil to give a 4-in. spark, to be used for producing X rays with vacuum tubes). Can Eng-Sept. 900 w.

8256. Electrolytic Copper and Silver Refining (An illustrated description of the electrical generating plant of the Guggenheim Smelting Co., at Perth Amboy, N. J., and of the electrolytic process). Am Elect'n-Sept. 1800 w.

8264. Mutual Induction of Parallel Distributing Circuits. Dugald C. Jackson (A contribution to the several treatments on the calculation of the inductance of transmission lines). Elec Wld-Sept. 19. 900 w.

8265. Electrical Waves in Long Parallel Wires. A. D. Cole (Abstract of paper read before A. A. A. S., Buffalo meeting. Facts described were brought out in experimental study undertaken as a preliminary to a research on the refractive index of certain liquids for electrical undulations as deduced from a measurement of the ratio of the wave-length in the material under investigation to that in air). Elec Wld-Sept. 19. 2200 w.

8275. An Arrangement of Resistance Boxes. A. O. Benecke (Diagrams with explanation of improved arrangement). Elec-Sept. 16. 300 w.

*8325. Some Distinctive Features of Continental Electrical Engineering Practice. Kenelm Edgcumbe and E. J. Fox (Read at students' meeting of the Inst. of Elec. Engs. Points out in what respects Continental practice in general may be said to differ from that in England, with a few of the advantages and disadvantages met with in the respective systems). Elect'n-Sept. 11. 5800 w.

8332. The Insurance of Electrical Plants. R. H. Pierce (Extract from paper read before the Northwestern Electrical Assn. The problem of safety the real question). Am Gas Lgt Jour-Sept. 21. 1000 w.

*8333. Applied Electro-Chemistry. James Swinburne (Points touched upon in the first of four Canton Lectures on this subject). Jour of Soc of Arts-Sept. 11. 4400 w.

†8348. Effect of Temperature on Insulating Materials. George F. Sever, A. Monell and C. L. Perry (Conclusions drawn from results of 102 tests on samples of materials. Discussion and communications). Trans Am Inst of Elec Engs-June & July. 6000 w.

†8349. An Experimental Study of Electro-Motive Forces Induced on Breaking a Circuit. F. J. A. McKittrick, with an introduction by Dr. Edward L. Nichols (Illustrated description of method employed, also a variety of methods for the recording of current curves. Brief discussion follows). Trans Am Inst of Elec Engs-June & July. 5000 w.

8359. Tesla's Electrical Condenser (The inventor's own description, with sectional view). Elec Rev-Sept. 23. 800 w.

8390. Electrolysis and Some Problems in Molecular Physics. C. L. Mees (Abstract of an address before the Physics Section, American Assn. for the Advancement of Science. The first part reviews the progress in the study of electrolysis). Elec Wld-Sept. 26. Serial. 1st part. 2000 w.

†8403. The Velocity of Electric Waves. Clarence A. Saunders (Investigation based on the phenomena of resonance. Historical review of past attempts, with description of method and apparatus used in this investigation, with results). Phys Rev-Sept.-Oct. 6000 w.

†8404. Admittance and Impedance Loci. Frederick Bedell (Read before the Physical Society of London. A study of the relations and principles). Phys Rev-Sept.-Oct. 1500 w.

†8405. Visible Electric Waves. B. E. Moore (Describes apparatus and method used by author in showing electric waves to a class. The method is serviceable for lecture purposes). Phys Rev-Sept.-Oct. 1200 w.

8491. Tesla's Electrical Oscillators (Illustrated description of Mr. Tesla's perfected transformers or oscillators The description is largely the exact language of the inventor). Elec Rev-Sept. 30. 2400 w.

8492. A Gas Battery Experiment. J. R. Payson, Jr. (Experiments with sulphuretted hydrogen in endeavoring to develop electrical energy direct from fuel. The writer thinks it presents features that may render it valuable). Elec Rev-Sept. 30. 1800 w.

8501. Protection Against Lightning for High Potential Power Transmission Circuits. A. J. Wurtz (Diagrams illustrating system of protecion with explanation). Elec Eng-Sept. 30. 500 w.

*8505. On the Magnetic Behavior of Electrolytic Iron, Nickel and Cobalt. W. Leick (Abstract from *Wied. Ann.* Investigations of the magnetic behavior of iron deposits, giving their susceptibility and intensity of magnetization in absolute measure). Elect'n-Sept. 18. 3500 w.

†8542. On a New Method for Reading Deflections of Galvanometers. C. B. Rice (Describes a method recently devised by Prof. C. S. Hastings). Am Jour of Sci-Oct. 1200 w.

8619. The Electric Fountain in Willow Grove Park, Philadelphia. H. S. K. (Illustrated description). Elec Eng-Oct. 7. 800 w.

8630.—$1.50. Notes on the Best Form of Cross Section for the Coils of a Galvanometer. Frank A. Laws (Experimental determination of the curves bounding the best form of cross section for two cases are given, when the needle is indefinitely short). Tech Quar-June-Sept. 700 w.

INDUSTRIAL SOCIOLOGY

Economic Effect of Appreciating Money.

THE first article in *Gunton's Magazine* for October is an attack upon the long-held and widely-accepted economic theory of bimetallists that (according to Mr. Balfour, who stated it in an address before the English Bimetallic League as "a great principle in national finance") "an appreciating currency is disastrous to the business of a nation." That this proposition has been accepted by many men—some of them of high reputation as economists—does not prove it to be true. Time and again has error been widely accepted as truth, and many economic theories that once commanded widespread approbation have been abandoned.

The effort of the author of the article reviewed is to prove the falsity of the proposition as stated by Mr. Balfour, at least in its application to the social status of the world at the present day. He begins this task by calling attention to the great change that has come over the nations of the world. Before the development of manufacturing industries, "national prosperity centered in the middle and upper classes, because they represented the great consuming power in the community for manufactured and artistic products; in fact, for everything which made for progress in the arts, sciences, literature, architecture, sanitation, education, domestic appointments, and all the higher phases of civilization. The laboring classes were consumers of little else than food-stuffs." The growth of the factory system has made essential "a broader social foundation, which the daily consumption of wealth by the laboring classes only could supply."

With this preliminary consideration of changed conditions are coupled the propositions: (*a*) "The basis of social welfare in all ages, and under all conditions, is the demand or market for products;" (*b*) "If the consumption of any particular class represents the controlling element of demand or consumption, the prosperity of that class constitutes the prosperity of the nation, because it furnishes the economic influence that sets in operation the forces which make the production and distribution of wealth profitably possible. Whatever fills that function in the economy of society constitutes the view-point from which the public welfare must be considered, and public policy conducted."

It is then argued that, as seventy per cent. of the population of the United States are wage- and salary-earners, these occupy the basic position, and that upon their welfare the prosperity of the country depends. Implicitly this is held to be true for every nation in which a majority of the people are wage- and salary-earners.

"They occupy this controlling position, not because they are superior in quality, but because, being more numerous, their consumption determines the market for all lines of commodities produced for sale. When we realize that the home consumption of the American people is equivalent to ninety-four per cent. of the entire products of the nation, the economic importance to national prosperity of the consuming power of three-quarters of the population is obvious. No elaborate reasoning is necessary to show that whatever affects the prosperity and consuming power of this three-quarters practically controls the prosperity of the nation. Consequently, the social condition and consuming power of the wage and salary class constitute the economic view-point of national prosperity, because the success of all lines of industry in which modern methods are employed depends upon the market sustained by their consumption. Point-lace, diamonds, and a few lines of art products may be sustained by the consumption of the profit-receiving class, or even by the few very rich, but industries in which large capital is required to produce best results, such as railroads, telegraphs, ocean transportation, and the numerous lines of manufacture, can be profitably sustained only through the consumption of their products by the millions."

If the argument, so far, be accepted as sound, it logically follows that the truth or falsity of Mr. Balfour's proposition depends upon whether an appreciating currency affects adversely or otherwise the welfare of wage- and salary-earners. And, though a certain policy may temporarily benefit "the payers of interest or the drawers of profits, . . . if it tends directly or indirectly to lessen the income and consuming power of this wage class, . . . it necessarily undermines the very source from which profits and interest can be paid." Therefore, rising wages or falling prices, either of these increasing "the purchasing power of a day's work," are maintained to be indications of increasing prosperity to a nation.

"The period of unparalleled progress and prosperity of which this country boasts is distinguished for both these economic movements. During the twenty-five years previous to 1893 wages rose and prices fell; so that laborers receive more dollars for a week's work, and more wealth for a dollar. In this absolute increase of wealth and welfare for a day's work consists the real progress of the nation.

"From whence does this increase of wealth to the wage class come? It is not a gratuitous gift from the capitalists and wealthy classes; it is the laborers' share in the new and constantly-increasing increment of wealth created by the economic forces of civilization. In other words, it is a transfer of a part of the profits resulting from the application of science and capital to enterprise. In reality the only progress the world ever makes is in the creation of new increments of wealth in some form of surplus, as interest, rent, or profits. These are the avenues through which all the increase of human welfare comes into existence. The distribution of this constantly-augmenting fund of new wealth to the masses constitutes the equities and industrial ethics of civilization."

The arbitrary Socialistic methods of restricting profits, confiscating rents, regulating rates of interest, or proscribing the size of large fortunes are condemned as "uneconomic and wasteful," and as impracticable, "because their enforcement operates directly to check the creation of the very fund which it is designed to distribute." It is admitted that the general complaint that the distribution of wealth is not now rapid enough has a foundation, but improvement is possible only through "economic and social influences which tend silently and constantly to disperse this increasing fund of new wealth."

"The laborer does not do perceptibly more work per day after receiving an increase of pay than he did before. Consequently, the employer is always reluctant to part with his surplus in that way, and frequently has to be compelled to do so through definite collective action on the part of the laborers, by strikes or similar means. This never can take place simultaneously with all laborers at once. All such struggles for direct increase of wages take place by groups or industries. It is now printers, now carpenters, now factory workers, now railroad men, etc. For a general rise of wages to obtain throughout the whole country, it will frequently take from one to two years, and even then some industries may not succeed in getting it. Consequently, the amount of added income to be obtained by the laborers through increase in money wages is, on the whole, slight, and costs a great deal to get it, often involving untold hardships among laborers and creating social disturbances.

"The distribution of wealth to the masses through the lowering of prices is much more economic and satisfactory in every way. It is always simultaneous, and distributes the benefits throughout the entire community. The fall of one or two per cent. in the price of any commodity silently takes its benefits into the home of every consumer of that product. It is more economic than strikes, in that it carries with it no acrimonious struggle of the laborers or disturbance of the community. It is more satisfactory in that it comes gradually and almost imperceptibly, like everything that comes through the normal operation of economic and social law."

In sum, then, the writer of the article reviewed argues that either a rise in wages or a fall in prices—the latter equivalent to appreciating money—is an indication of prosperity in the nation wherein it occurs, while a depreciating currency "is an impairment of the income of actual wealth received by all who live on stipulated incomes."

The Trading World in 1860 and in 1890.

We here repeat a previous statement that some of the best articles pertaining to industrial sociology appear in the technical papers. When any one of these is prompted to step aside from the strict line of its technical routine to discuss such a question, the topic treated is usually one that has either a direct or indirect bearing upon the special industry or industries to which the publication is devoted, and it is generally a thoughtful, well-prepared essay upon the particular topic discussed. Such an article, in *Engineering News* (Sept. 17), is "The Relative Size of the Trading World in 1860 and in 1896."

It begins with the proposition that "reduction in time and cost in the transport of goods are the two important factors in promoting international trade, or even an exchange of commodities between different parts of the same country." It then proceeds to state what this reduction has been during the three last decades. Thus it is shown that "for all trade purposes" San Francisco is as near to New York now as was St. Louis in 1860, and that this particular instance is a type of the general reduction of time and cost of transport between all parts of the civilized world.

"If we take any date anterior to the introduction of railways, or previous to 1825, we may safely consider each nation separately, from a manufacturing and trading point of view. Each supplied its own wants, mainly from material and labor within its own borders, and was little affected by what its neighbor was doing in a similar line. Foreign trade was practically confined to the import of the luxuries of life, and commercial rivalry could be hardly said to exist,—at least, from the present point of view. Without railways at all, and with highways in a generally very bad condition, intercourse was limited within the boundaries of any one State; and the centralization of population, so characteristic of the present age, was impracticable, owing to the lack of means for supplying such centers with food and other necessaries of life. Up to 1825 the processes of manufacture were still generally crude, and closely followed the practice and traditions of a more remote period. The volume of foreign trade was then relatively large; but this trade was conducted in comparatively small and slow ships, and over seas imperfectly known. The advent of railways and the gradual development of the steam engine and of processes of manufacture brought about a decided change; but even up to 1860 the broad effects of this change were only beginning to be felt, as compared with present events. Clipper-built sailing ships thirty-four years ago outstripped the paddle-wheel steamers on the ocean in the race for foreign markets, and on land railways were, to a large extent, being pushed forward into undeveloped regions, with the resultant growth yet to be realized."

Though the forces that have wrought so great changes were in active operation prior to 1860, that date is arbitrarily selected as a starting-point for the purposes of the article under review, and the increase in the population of North America and Europe during the three decades chosen is noted. The gain has been 123,400,000. Europe and North America alone are considered in this increase, because in the countries of these geographical divisions "scientific and engineering progress had its origin." It might have been added that, with the exception of Japan and the British colonial possessions, it was alone in these geographical divisions of the world that the great triumphs of this progress have been achieved.

"The population of Asia and Africa, now estimated at nearly 1,000,000,000, had little or nothing to do with bringing about present progress; but it enters into commerce as an important factor in inducing western nations to manufacture for these teeming millions and to utilize the cheap labor found there in supplying raw materials for general consumption. Were this eastern population ever to advance to a competitive point in intelligent productive capacity, the effect upon the rest of the world can only be guessed at by political and social economists; and that there are possibilities in this direction the sudden rise of Japan to the position of a power among nations is a sufficient indication."

The increase in productive capacity corresponding with this growth of population, without increase in the means of manufacturing and transporting products, would have had little or no effect upon the commerce of the world; but the growth of railways from an aggregate of 66,290 miles in 1860 to 390,000 miles in 1893 has supplied facilities for transportation by land in excess of the increased demand for such facilities, while on the sea steam has supplanted sails, and facilities for ocean traffic have likewise greatly increased. In 1860 the steam-ship tonnage of the world was 764,000; to-day it is estimated as over 8,000,000. As a consequence of these advances, and the enormous facilities for verbal communication afforded by quick passages of mail steamers, by the telegraph, and by the telephone, international traffic has more than doubled within the period selected for comparison.

The effects of all these influences upon the social status of mankind are well summed in the closing paragraph of the article.

"But enough has been said to plainly indicate that, while the world's productive capacity, as measured by its gain in population, has normally increased in the last thirty years, the facilities for utilizing this capacity in manufactures and in supplying the world with the product of this labor have grown at an abnormal rate. As before remarked, this world of ours, measured by time and the cost of transport of men and goods from one part to another, is very much smaller than it appeared to be to our fathers. And the immediate effect of this shrinkage is a certain unity of interests throughout the globe, and a sensitiveness to events commercial and financial outside of our own country, that never before existed, nor could exist under previous conditions. The wars of conquest and of personal ambition that so long occupied the time and expended the resources of nations are giving way to industrial wars, within nations and between nations. And, in the adjustment which is now going on everywhere, the present scientific and engineering advance, which has alone made our material and commercial growth possible, must be well and duly considered."

Consular Reforms Needed.

A CRITICISM of the consular system of the United States is made in a paper entitled "A Hindrance to Our Foreign Trade" in *The North American Review* for October. The author is Mr. Thomas R. Jernigan, United States consul-general for China. If, as he says, the defects in our consular system are adversely affecting the interests of our foreign trade, he has done the country a service in pointing out these defects, which are of a character to be easily dealt with. After recounting the incidents of his appointment, his entrance into the consular service in Japan, and his subsequent transfer to Shanghai as consul-general of the United States in China in May, 1894 (which he does to illustrate the principle that interruption of the tenure of office is an embarrassment to the service), he says that a consul entering for the first time upon the duties of his office is at a serious disadvantage with one whose tenure of office has been uninterrupted. He has to learn what has been long familiar to his older colleagues, and is, in the interval of tutelage, not "in a position to measure the importance of the commercial questions arising, and to respond promptly to any fresh conditions which might be developed by a growing commerce." The value of official experience is to an extent thus neutralized by frequent changes.

Fault is also found with the insufficient salaries paid, and with our system of leasing consulate buildings. These features of our service are compared with salaries paid to the consuls of other nations, and the tenure by which their consulate buildings are held. "The salaried officers of the consulate-general of the United States at Shanghai are: the consul-general, $5,000; vice-and deputy-consul-general, one office with no salary, though the incumbent generally receives the $1,600 allowed the consulate-general for a clerk; interpreter, $1,500; marshal, $1,000; and jailer, $500,—the salaries for the consulate-general proper amounting in all to $9,600. As the consular system of Great Britain is the system to which ours is most nearly kindred, and as the foreign commerce of Great Britain is larger in tonnage and value than that of any other nation in the world, I will take the British system for a standard of comparison.

"The salary of the consul-general of Great Britain is $10,000, with $500 as registrar of British shipping; consul, $6,000; vice-consul, $3,500, with allowance, as assessor to the mixed court, of an additional $1,000; another vice-consul, at $3,250; crown advocate, $2,500; and chief clerk, $2,250. We must also include the salaries paid several student interpreters and under clerks, all of which would make the expenditures about $40,000, or, in round numbers, $30,000 more than the government of the United States expends upon its consulate-general at the great commercial center of Asia.

"The comparison may be extended to the tenure by which the buildings of the consulate-general of these two governments are held. The grounds for the British consulate-general cover about three acres, beautifully laid out, and enclosed by a brick wall over five feet high. Within the enclosure are three large brick buildings, each two stories high, with neat and massive appearance. The center building is for the offices, in which all business pertaining to the consulate-general is transacted. One of the outer buildings is the residence of the consul-general and his family, and the other is for the consul and his family. Both are comfortably and substantially furnished by the government, and supplied with the necessary servants. To support the dignity of his position and extend the influence of his office, the British consul is allowed a certain sum for entertaining." The British consulate buildings are held in fee simple by the British government, and are beautifully situated in an ample, walled inclosure. The American consulate, on the contrary, has been obliged to remove from the convenient quarters it once occupied to less convenient ones, because the salary paid the consul would not permit retaining them at the increasing rent demanded; and, unless other provisions than those now existing be made, the United States consulate is likely to be forced altogether from the foreign concession. Thus the parsimonious way in which our consular service is conducted is anything but conducive to our honor as a nation or to the efficiency of the service, and it affects adversely the influence our representatives abroad are expected to exert upon foreign trade. This state of things contrasts badly with the liberality of the British consular service, and, as it reflects upon our national honor abroad, it should be reformed without delay.

The Trades Union Congress.

An editorial in *Engineering* (London, Sept. 18) reviewing the recent trades union congress in Edinburgh seems not too indulgent to some of its proceedings, which are criticised with some severity, but concedes that, in the main, the proceedings had very much more of the "business-like steadiness . . . characteristic of Englishmen" than has been manifested at other recent congresses.

It is asserted that the report of the parliamentary committee was "mostly a record of failures." The presidential address dealt with "practical measures rather than theoretical disquisitions." The debate on the report contained reflections upon the international congress, about which "some hard things were said." A resolution was moved for an eight-hours day for all trades, and was adopted by a vote of 211 to 34. Of this vote our cotemporary says "that it was the best thing that could happen, for now the advocates of the hard-and-fast eight-hours day by act of parliament will see how such a measure would strike a blow at many important industries. Nothing is more easy than a wrong step or a false one; nothing more difficult than to retrace that step, and to avert the consequences which have been incurred."

A resolution demanding an amendment of factory laws with reference to unhealthy trades, and an extension of inspection by operative inspectors, including the inspection of "all vessels and craft in port, river, dock, or canal," was voted unanimously.

On the third day of the convention the reporters of certain Scotch newspapers were requested to withdraw, and, in the act of retiring, were contumeliously hissed. *Engineering* styles this action "one of the follies of the congress." The request that these reporters should withdraw practically amounted to their expulsion, as a resolution to expel them undoubtedly would have followed an attempt to remain. The reason for the request was that the reporters represented non-union papers.

A resolution to nationalize the land, mines, minerals, royalty rents, and railways, and to municipalize all water, artificial light, and tramway undertakings, was adopted by a vote of 172 to 47.

A resolution against the employment in factories during the day-time of children under the age of fifteen years, and, in the night-time, of children under the age of eighteen years, was adopted by a vote of 118 to 105.

Many other resolutions were passed, but they were comparatively unimportant. Those named well indicate the attitude of the British trade unions, and, in the resolution relating to the nationalizing of land, mines, etc., their socialistic tendency is plainly manifested.

GUNTON'S MAGAZINE says "the *Evening Post* is right. After defeating the free coinage of silver, the first step towards giving us a sound currency system is the retirement of the greenbacks. We hope the *Post*, *The Journal of Commerce* and the other papers which recognize the importance of this subject, will continue the campaign of education with increased vigor until the legal tender paper money shall disappear from the currency system. *Nothing but standard coin should be legal tender*. It is high time that this country passed from the era of government fiat money to that of sound business banking." If the sound money advocates are right there can be no other logical conclusion, and we join in urging this measure as an immediate necessity. Standard coin was "the money of the constitution," and standard coin should be the *money* henceforth.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*8122. Our National Policy and the Industrial Outlook. Cuthbert Mills (Outlining the probable Republican policy in case of McKinley's election). Eng Mag-Oct. 2200 w.

†8135. Saxon Land Credit Association (Translation of the rules and regulations of this association, printed in the belief that the system may be adopted with benefit to the farming community of the United States). Cons Repts-Sept. 7500 w.

†8159. The Farmers and the Silver Movement. Henry Loomis Nelson (An attempt to prove that farmers in the United States have not suffered from the demonetization of silver, as many suppose, or assume, and that low prices for agricultural products are the result of other causes,—notably competition in the world's markets by the Argentine Republic, India, and Russia, and a greatly increased production). Bankers' Mag, N. Y.-Sept. 2800 w.

*8182. Commercial and Industrial Progress in Japan (Compiled from returns published in Japan for the two years, 1889 and 1895, from which an estimate of progress since 1889 can be made). Engng-Sept. 4. 700 w.

8203. The Influence of Money in History (Historical review). Min Ind & Rev-Sept. 10. Serial. 1st part. 2000 w.

8271. The Relative Size of the Trading World in 1860 and in 1896 (A well written, thoughtful and suggestive editorial with statistics of the growth of railway and marine facilities for transportation, compiled from authoritative sources). Eng News-Sept. 17. 2500 w.

8314. American Trade Prospects on the Baltic. Charles E. Currie (The author, special commissioner of the Louisville, Ky., Board of Trade, gives favorable views of the prospect for extension of American trade with northern Europe). Bradstreet's-Sept. 19. 2000 w.

†8350. Hangchow, the New Treaty Port of China (Concise but full report of the industries

of the province of Chêkiang, and the future prospects of Hangchow, its capital, as a treaty port. The city of Ningpo is said to be the richest city in China, and it is the center of the most extensive silk and tea districts in the world). Cons Repts-Sept. 24000 w.

†8355. United States Trade with Uruguay (Information given in reply to numerous letters of inquiry). Cons Repts-Sept. 1600 w.

*8387. Municipal Reform. William Howe Tolman (The general awakening to the need of municipal reform, and what is necessary to effect the desired changes). Arena-Oct. 3500 w.

8393. A Fiat Money Experiment in the Past (Review of "Fiat Money Inflation in France," by Dr. Andrew D. White, recently issued by D. Appleton & Co. History of the French assignats). Bradstreet's-Sept. 26. 1400 w.

8394. Foreign Governments in Default (Information supplied by the Corporation of Foreign Bondholders, a London institution organized to supervise the interests of British investors). Bradstreet's-Sept. 26. 900 w.

*8399. China: Her Resources, Openings, and Opportunities (A general review of the industries and present requirements of the people of China, and the possible and perhaps probable industrial awakening that awaits this most conservative of nations). Mach, Lond-Sept. 15. 3000 w.

*8417. Foreign Import Duties on Wheat Flour (Tabulated statement). Bd of Trd Jour-Sept. 250 w.

*8418. Tariff Changes and Customs Regulations (Russia, Norway, Germany, Belgium, The Netherlands, France, Portugal, Spain, Italy, United States, San Domingo, Venezuela, Brazil, Peru, British India, Barbados and Gambia). Bd of Trd Jour-Sept. 5000 w.

*8429. The Trades Union Congress (Editorial review of the congress, the addresses delivered, and the probable effect of its proceedings upon the status of labor in the United Kingdom and in other countries). Engng-Sept 18. 1800 w.

*8475. How to Recover Our Waning Trade (The first part considers the advisability of abandoning rigid adherence to free trade as a national policy and intimates that its full maintenance is not compatible with British commercial prosperity). Ir & Coal Trds Rev-Sept. 18. 2200 w.

*8488. Free Coinage and Life-Insurance Companies. John A. McCall (Reply to the assertion of Mr. Bryan in his speech of acceptance, that a rising standard must be of more benefit to the companies than to the policy holders). Forum-Oct. 2500 w.

*8489. Free Coinage and Trust Companies. Edward King (How the free coinage of silver would affect those whose property is in the special care of trust companies). Forum-Oct. 1800 w.

*8490. Free Coinage and Farmers. John M. Stahl (The direct effect will be that which the free silver advocates declare it their object to avoid). Forum-Oct. 2800 w.

8494. Drawback Rates (Summary of the United States revised drawback regulations upon all articles which have been granted the rebate privileges conferred under the provisions of Section 22, of the present tariff law). Ir Age-Oct. 1. 3000 w.

†8508. A Hindrance to Our Foreign Trade. Thomas R. Jernigan (The hindrance herein noted arises from defects in our consular service as related to China. These defects are severally pointed out and their effects upon trade stated). N Am Rev-Oct. 3600 w.

†8525. Why American Industry Languishes. Hilary A. Herbert (Fear of the future, and agitation for free silver are the causes assigned, and to the substantiation of which the argument is directed). N Am Rev-Oct. 2500 w.

*8573. Economic Effect of Appreciating Money (Combats the fundamental idea behind all "cheap money" theories, viz., that national prosperity is promoted by depreciating money). Gunton's Mag-Oct. 3500 w.

*8574. Government by Injunction (Opposition to the United States court injunctions for preventing and controlling strikes is justified, and it is maintained that in the Ann Arbor and Chicago strikes a new and unanticipated use of the power of injunction was made, which cannot be defended on general principles). Gunton's Mag-Oct. 2500 w.

*8575. The Foreign Market Delusion (Combats the proposition that the greatness of a nation depends upon the extension of its foreign markets. The theory is alleged to have been borrowed from Manchester economics of half a century ago). Gunton's Mag-Oct. 1000 w.

*8576. Strikes in Russia (Translation of a letter to the Belgian *Independence* from its correspondent in St. Petersburg. An account of the labor movement in Russia. Peaceful methods as yet prevail with no sign of disorder). Gunton's Mag-Oct. 1700 w.

*8577. The Industrial Development of the Extreme Orient (Combats the gloomy view some are taking of the effect of industrial development in the Orient upon industry in other parts of the world, and thinks it will result in benefit rather than injury). Gunton's Mag-Oct. 1800 w.

*8578. The March of Invention (Review of the last United States patent office report). Gunton's Mag-Oct. 1800 w.

*8579. The Economics of Organized Charity. Rev. M. McG. Dana (The questions now faced by charity are regarded as essentially economic, relief being a mere temporary expedient, while the main study is the improvement of conditions producing distress). Gunton's Mag-Oct. 1900 w.

*8580. Convict Labor (Review of Bulletin No. 5 of the National Dept. of Labor. Summary of statistical information therein given). Gunton's Mag-Oct. 1200 w.

*8649. The Reflux of Gold to America. W. R. Lawson (The return of gold to America is treated as nothing remarkable, especially when the enormous export of silver during the period of this reflux is taken into account. United States treatment of the money question is sharply criticised). Bank Mag, Lond-Oct. 4500 w.

MARINE ENGINEERING

Electricity in Marine Engineering.

THE extent to which the successful application of electricity to marine use has been carried and its possible and probable future as an adjunct of marine engineering form the theme of a serial paper by Lieutenant B. A. Fiske, U. S. N., in the *Electrical World* (Sept. 23).

For a long time the magnetic compass was the only application of electric energy used as an aid to navigating the high seas. It is quite safe to say that without this aid no great ocean would ever have been crossed, except perhaps by some unfortunate ship blown out to sea in spite of human effort to prevent such a catastrophe. So great would have been the hazard of such an undertaking that the boldest would have shrunk from it; and the phrase "a ship without a compass" has become proverbial as descriptive of a type of action uncontrolled by principle. No other application of the great store of electric energy which modern science has shown to pervade the universe will ever be so far-reaching in its effects as the first and greatest. It is, therefore, with some surprise that we fail to find in the introductory to Lieutenant Fiske's paper any reference to it, unless the allusion to "better control of a ship" in the following quotation implies the use of the compass. We think, however, that the author did not have the compass in mind when he wrote the passage. He says:

"In examining the results of the use of electricity in naval life, we must admit that, up to the present time, electricity has fulfilled all the promises it has given us. It has made our ships brighter, cleaner, and healthier; it has lightened the task of enforcing discipline: it has increased the accuracy of gunnery; it has made instruction interesting; it has assisted the surgeon in diagnosing wounds and relieving pain; it has given the captain better control of his ship, and the admiral better control of his fleet; it has added an element of intelligent interest and expectation to each new addition to our navy; and it has brought into active sympathy with the sea-going class a large and influential body of progressive men on shore."

All this is true of the modern marine electrical appliances which form the staple topics of the paper.

A difficulty with which the introduction of electrical aids to the working of ships has had to contend is found in the lack of any incentive for officers and men to study electricity; and the slowness with which these devices have come into use is, therefore, not surprising. The fact that the use of electricity on ships has so much extended already is rather an indication that seamen are more progressive than is generally supposed.

In our department of electricity will be found a review of a paper recounting the troubles of electricians at sea, in which many difficulties not encountered on land are set forth. It would appear that Lieutenant Fiske takes an opposite view, and regards a ship as presenting exceptionally easy conditions for the installation and operation of electric machinery and appliances.

"It is frequently stated that the reason for the slow progress of electricity in naval matters is the difficulty of meeting the conditions of ship life; but this position is hardly tenable, because the conditions for the use of the electric light, electric motors, and telephones in warships are in reality not nearly so severe as they are in hundred of positions along the coasts of the country and through the long stretches of the mountainous and comparatively unpeopled sections of our western lands. In reality there can hardly be found, outside of the college laboratory, conditions which are in many respects so favorable as those to be met on board a modern warship. In the first place, the distances through which the electric current are to be transmitted are extremely short; in the second place, the item of expense does not control to so great a degree as it does in the operations of commercial life; in the third place, in case of any accident or derangement, the place where this accident or derangement occurs is always within a few feet of somebody, so that it will not have to be hunted for, as frequently happens with apparatus on shore, through miles of country; in the fourth place, the solidity of the structure of a ship and the excellence of all of the mechanical appliances are in great contrast with the flimsiness of the structure and the cheap character of the installations which have, for financial reasons, in many cases to be made on shore."

The rivalry between electrical and mechanical devices which has been in progress on land also reaches into marine engineering. For instance, in signalling there are electrical methods and methods purely mechanical; a bell may be rung by pulling a wire, or by an electric current sent through the same wire, and so on.

"In spite, however, of the successful efforts of the genius of electricity in ameliorating the conditions of shipboard life, there are still many objectors; and it is a fact that a contest is going on between electro-mechanical and other mechanical apparatus in very many of the important operations in ships and forts, which promises to be as lasting and as bitter as the contest between steam and sails; and yet it is easy to one who watches the drift of modern engineering practice to see with which the ultimate victory will reside. Just now the fight is going merrily on, and the public benefits by the competition. No sooner does an electrical device score a success than some ingenious person does the same thing with mechanics; and no sooner does an important mechanical invention accomplish some new thing than an electrician throws it altogether into the shade by a novel use of electricity. It may be stated as a general law—but with the distinct understanding that it is only general—that mechanical appliances have the advantage of greater simplicity of principle, and that electrical appliances have the advantage of greater simplicity of operation. To paraphrase this statement, mechanical appliances are more easy to understand, but electrical appliances are more easy to use. Mechanical appliances require less instruction for their use; electrical appliances render available a higher grade of intelligence, and also require a higher grade of intelligence. Electrical appliances strive for an idea; mechanical appliances do what is required at the moment. The advantages of maturity and experience are on the side of mechanical apparatus; but youth and the promise of the future reside with electricity. Mechanical appliances are less apt to deteriorate from disuse; electrical appliances are less apt to deteriorate from use. Mechanical connections are liable to give out under the sudden strain of emergency; electrical appliances, from their nature, suffer little strain in use, and are not apt to fail in emergency, if found to be in good condition before the emergency occurs. A mechanical connection, if broken or injured, gives plain sign of the whereabouts of the trouble, but the trouble is with difficulty repaired. A trouble in an electrical connection is sometimes hard to find, especially if the apparatus is not thoroughly understood, but, when found, is remedied with ease. The difficulty of repairing a break or disarrangement of a mechanical appliance, caused by a stress, is usually in proportion to the greatness of the stress; but, with electrical appliances, the cause of trouble is usually minute, and can be repaired as soon as found."

The slipshod manner in which much of the shipboard electrical work is done has tended to retard progress. It is this, more than anything else, that has given rise to complaints of the untrustworthiness of electricity. "It has always been so easy to put in a battery, or a bell, or a dynamo, which would work for a week that in very many cases it has not worked any longer." Notwithstanding, electricity is becoming more widely used at sea, and the era of the slipshod work above deprecated is, let us hope, coming to an end.

The paper treats marine electrical appliances under the following heads: Electric Lighting; Electrically-Operated Steam Whistles; Motors. The advantages and disadvantages of steam and electric motors for special marine purposes are compared and discussed.

The Immediate Future of Lake Traffic.

THE improvements in the river system of our great lakes, allowing for the safe passage of vessels of much heavier draft, and the great increase in length and tonnage of vessels engaged in lake traffic, have, according to the Duluth *News-Tribune* (quoted by *Seaboard*, Oct. 1), inaugurated a new epoch in the history of the lake marine, which will be fully developed at, or shortly after, the opening of next season's navigation.

Of Duluth as a lake port it is said that the improvements, as regards draft of water in rivers connecting with the lake system, place it on an equal footing with Chicago, and grain can now be shipped from that point for the same freight charge as from Chicago. With the completion of the waterway between Duluth and Buffalo, it is predicted that lake freights will fall to a lower average than at present rules. A most potent influence in reducing freights will be the many five-thousand-ton vessels lately built. These "four-hundred footers," as they are called, carry 4,500 tons with a draft of fifteen feet; and, when they can load to seventeen feet, they will be able to compete for freights with lower rates than have ever been possible before.

"Vesselmen are of the opinion that the big fellows will crowd many of the little ones out of the carrying-trade next season. A prominent vessel man of Duluth says that such an effect is inevitable, as one of the larger class of vessels can be operated at a cost of only ten per cent. in excess of the cost of operating a vessel of two thousand tons. The big vessels, therefore, can continue in the carrying-trade, and pay dividends where the small vessels would do business at a loss. It is claimed the big vessels can carry ore from Duluth to Erie at fifty cents a ton, if the rate should go down to that figure, but this is denied by well-informed vesselmen. Captain McDougall once made the statement that he could carry ore for that price, but there are other vesselmen that are skeptical, unless, they say, the captain means he could carry it at a loss. Captain McDougall, in making that assertion, contemplated whaleback steamers with tow barges to transport the ore. In any event, the day of dollar ore and six-cent wheat has gone, never to return except under some extraordinary combination of circumstances. Whether the change will be for the better for the owners of lake-vessel property remains to be seen. The vessels of two thousand tons' carrying capacity, of which there is a large number, have been great money-makers in the past, and it is assumed they will continue to be profitable property in seasons of heavy freight movement; but the days of their glory have departed."

There have been many record-breaking cargoes during the season about to close. "The Coralia started the record-breaking in ore, and the Rees in wheat. The Coralia still holds the ore record at 5,088 gross tons. The Lake Superior ore record is held by the Bessemer, which loaded out of Duluth 4,172 gross tons a week ago. The Lake Superior ore record has been shifted from one to the other of three vessels this season,—the Queen City, Aurania, and Bessemer. It is expected the Queen City will take the ore record from the Bessemer before the end of the season. The Bessemer's ore record is only three tons better than the Queen City, as it now stands. The Queen City holds the record for the heaviest cargo of any commodity ever floated on Lake Superior, however. It consisted of 157,000 bushels of wheat, or 4,710 tons. The Queen City is the greatest carrier on the entire lake system, despite the performance of the Coralia already mentioned. The Coralia's cargo of ore represented in net tons 5,700, but she drew so much water that she had to lighter to get to her dock. The Queen City carried 207,500 bushels of corn out of Chicago a short time ago without attracting much attention, but it was the greatest cargo ever loaded on the lakes, amounting to 5,810 net tons. As the Queen City carries a greater cargo on the same draft than any other boat, it is presumed she can protect the records she has made the past summer, until something new is produced that can eclipse her performance." However, the Queen City is likely to have a rival in a new vessel contemplated by The American Steel Barge Co., which is expected by some to break all the records of cargoes hitherto transported on the great North American lakes.

The Safety of Modern Ships.

THE table herewith presented gives the total number of registered vessels belonging to the United Kingdom—exclusive of fishing vessels—lost at sea during each of the fifteen calendar years, 1881-1895, and of the lives of crews and passengers lost in them.

In a paper read before the British Association Dr. Francis Elgar presented this table, and remarked upon the increased safety of modern passenger-ships, as shown by the statistics of the British board of trade. Taking the last six years first,—namely, from the end of 1889 to the end of 1895,—no regular passenger steamer of any size or class whatever was lost during that period, except by collision, stranding, or fire. Surely, this is a remarkable result, and one showing that the principal matters now requiring attention are precautions against stranding and collision, and the internal subdivision of the hulls of ships so as to make them as safe as possible in the event of injury. In 1895 only 23 lives of passengers in steamers were lost through the loss of the steamers. This does not include any lives lost in minor casualties. In 1894 the lives lost through the loss of steamers numbered 1,157, 1,150 of which were Chinese soldiers lost in the Kowshing, sunk by a Japanese man-of-war; in 1893, 27 passengers; in 1892, 67 passengers,—44 in the wreck of the Roumania on the coast of Portugal, and 20 in the loss of the Bokhara on the Pescadores; in 1891, 6 passengers; in 1890, 142 passengers, 98 of whom were lost with the Quetta in Torres Straits; while in 1888, 712 passengers were lost, these including 703 passengers of the small steamer Vaiturna, lost near Bombay.

The ships as designed and constructed have successfully defied the worst efforts of wind and sea to send them to the bottom, so long as they were navigated clear of obstructions, and were protected against fire. One of the chief lessons taught by a study of the statistics of losses, and of the principal causes of loss of ships to-day, is the necessity of endeavoring to make ships as safe as possible by internal watertight subdivisions, in the event of injury through collision or stranding. There appears no reason why large passenger steamers should not be subdivided, so as to be safe against the effects of any single blow from outside, and this is the case with many of the fine steamers, transatlantic and others, that trade from this port. The case may be different with regard to many cargo steamers; it may not be possible to make them absolutely safe by the same means, without rendering them valueless for trading purposes.

	Steamships.			Sailing vessels.			Total.		
	Vessels lost.	Lives lost.		Vessels lost.	Lives lost.		Vessels lost.	Lives lost.	
		Crews	Pass.		Crews	Pass.		Crews	Pass.
1881	135	636	196	645	1604	17	780	2240	213
1882	146	601	14	458	871	16	604	1472	30
1883	142	772	67	470	1123	21	613	1895	88
1884	146	377	129	334	667	75	480	1044	204
1885	126	400	33	304	634	17	430	1094	50
1886	126	351	32	394	644	15	520	995	47
1887	128	633	87	252	519	267	380	1152	352
1888	109	351	712	287	547	56	396	898	768
1889	105	301	31	215	391	20	320	692	51
1890	129	427	142	255	664	18	385	1081	160
1891	129	330	6	319	695	12	448	1025	18
1892	90	359	67	207	633	31	297	992	98
1893	122	521	27	241	483	9	363	1004	36
1894	128	379	1157	214	546	8	342	925	1165
1895	100	322	23	195	637	20	295	959	43
Total for 15 years	1861	6820	2721	4971	10,648	602	6652	17,468	3323

With reference to water-tight bulk-heads Dr. Elgar maintained that ships should be so designed that they would float with any two departments full, and that the two engine rooms should be divided by a middle-line bulkhead, as otherwise a slight injury to one might involve the entire loss of propelling power. Notwithstanding the attention given to this subject, most sailing ships have only a collision bulkhead.

IT is announced that the Belgian government is about to begin the construction of a very extensive system of docks at Ostend at a cost of about $5,000,000. These docks will completely supplant the quays of the old harbor, and are to extend inland to a distance of between one and two miles. The warehouses will be built after the model of those at Antwerp, and a railway system will run around the docks.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*8163. The Mercantile Ship-building of the World (Compiled from the carefully prepared statistical tables of the committee of Lloyd's Register of British and Foreign Shipping). Eng's Gaz–Sept. 1600 w.

*8164. Marine-Engine Design of To-Day. Henry M. Rounthwaite (A paper read at the Inst. of Junior Engs. A general review of the present features of marine design, both for merchant vessels and military purposes, but principally related to merchant service). Eng's Gaz–Sept. 4000 w.

*8169. Boiler of the Steam Yacht Scud (Illustrated description of a Blenchynden boiler placed on this yacht). Eng, Lond–Sept. 4. 900 w.

*8172. Fundamental Corrections on the "Admiralty Formulas." Robert Mansel (The position is taken that either Newton was wrong in the enunciation of his scholium to the third law of motion, or that the variable Admiralty constants are a misapprehension. In pursuance of the subject mathematical methods are employed). Eng, Lond–Sept. 4. 3000 w.

*8178. Caissons for the New North Docks, Liverpool (Illustrated description). Engng–Sept. 4. 700 w.

*8179. Electrically Driven Machine Tools for Naval Construction (Illustrated description of a number of portable tools recently introduced into the arsenal of the Austrian Lloyd's at Trieste). Engng–Sept. 4. 500 w.

*8180. The Reorganization of the French Marine (Editorial review of the proposed reorganization, which is expected to lead to a higher standard of efficiency). Engng – Sept. 4. 2500 w.

8236. Experiments with Ship Models (Illustrated description). Sci Am Sup–Sept. 19. 1500 w.

*8289. The French Naval Manœuvres (Illustrated description with particulars of the armored ships that participated). Engng-Sept. 11. Serial. 1st part. 2200 w.

*8310. The Five-Crank Engines of the S.S. Inchmona (General description with two-page illustration). Eng, Lond–Sept. 11. 2200 w.

*8377. From Light to Light. Kirk Munroe (A description of the Armeria, one of her regular cruises, the light-houses supplied by her, the supplies delivered, and customary incidents of such a cruise. Popular and entertaining style. Illustrated). Scribner's Mag–Oct. 7300 w.

8383. Electricity in Naval Life. B. A. Fiske (An examination of the results of electricity in naval life, in which it is affirmed to have fulfilled all its promises). Elec Eng–Sept. 23. Serial. 1st part. 2500 w.

8389. Electrical Features on the "St. Paul." (Interesting illustrated description). Elec Wld–Sept. 26. 2700 w.

*8431. On the Relation of Speed and Displacement in Racing Yachts. J. T. Bucknill (A mathematical thesis by Colonel T. English, which it is stated proves that in yachts of the present type, the speed varies as the twelfth root of the displacement). Engng–Sept. 18. 900 w.

8495. Government Dry Dock at Port Orchard, Puget Sound, Washington. A. McL. Hawks (Illustrated description). Sci Am–Oct. 3. 1300 w.

8496. The Disinfecting Boat of the New York State Board of Health (Illustrated description of the vessel and its disinfecting appliances, bath, sulphur furnace, and disinfecting oven). Sci Am–Oct. 3. 800 w.

8497. Electric Turret for Armorclads. From *La Nature* (Illustrated description). Sci Am Sup–Oct. 3. 700 w.

†8509. Our Neglected Shipping. Alex. R. Smith (An argument for the protection of American shipping by means of discriminating duties, taxes, etc). N Am Rev–Oct. 3300 w.

*8527. The United States Armored Cruiser "Brooklyn" (Illustrated description). Am Eng & R R Jour–Oct. 1800 w.

8529. The New Era on the Lakes (The improvement of lake ports, and the increase of the size of lake vessels have inaugurated the era discussed, in which Duluth, it is anticipated, will rival Chicago in the lake commerce. From the *Duluth News-Tribune*). Sea–Oct. 1. 1100 w.

8552. The Discovery and Repairs of a Break in the Intermediate Steam Chest of the Port-Engine on the U. S. S. Philadelphia. W. N. Little (Illustrated description), Power–Oct. 1400 w.

8554. Official Speed Trial of the Armored Cruiser Brooklyn. W. N. Little (Description of the vessel and summary of data obtained during the trip). Power–Oct. 2000 w.

*8566. H. M. S. "Powerful" (The first part treats of the boiler installation. Illustrated description). Engng–Sept. 25. 3000 w.

*8571. Safety in Ships (Discourse delivered before the British Assn., by Dr. Francis Elgar. The primary conditions of safety are treated at length. Appendix giving number of vessels lost at sea from 1881 to 1895 inclusive, with particulars). Eng, Lond–Sept. 25. 4700 w.

8650. Marine Engineering (Written for the purpose of giving to young men intending to become sea-going engineers an idea of the conditions and work in this occupation). Lord's Mag–Oct. Serial. 1st part. 1200 w.

*8652. The Mercantile Ship-Owning of the World (Tabulated statements of the number and tonnage of vessels and the countries to which they belong . Eng's Gaz–Oct. 1600 w.

*8653. Engines of the Paddle-Steamer "Princess of Wales" (Illustrated description). Eng's Gaz–Oct. 500 w.

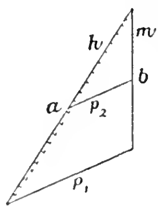
MECHANICAL ENGINEERING

The Prytz Planimeter.

CAPTAIN H. PRYTZ, the inventor of the original stang planimeter, contributes two communications to *Engineering* (Sept. 11). The first of these refers to the illustrated description of the so-called Scott planimeter, reviewed in our October number, and the second to an illustrated description of Professor Goodman's instrument, in which compensation for error is made by a scale with increasing divisions. It is fair to Captain Prytz, who implies an unjust appropriation on the part of Mr. Scott, and who also criticises the form of the instrument claimed by the latter, that his letters should be reviewed here, more especially as in our October review we—perhaps rashly—expressed approval of the Scott instrument. It seems that in this Captain Prytz disagrees with us. He says:

"At first the simple form, contrasting with the complicated theory, puzzled men who took an interest in planimeters; but, as theory showed that the instrument could not, as all other planimeters, give a mathematically correct result, though it gave certain limits within which this result must lie, it could not get into popular use till the practical man took it in hand. He had felt the inconveniences of the complicated instruments, which are easily put out of order by dust and careless usage. After my planimeter has been tried in practical use, especially in England and Germany, its useful results won credit to such a degree that the above-mentioned defect was nearly forgotten. When Mr. Scott asserts that the stang planimeter is as accurate as, if not more so than, the Amsler, he goes too far, especially if the due proportion between the length of the instrument and the dimensions of the figure to be measured be not maintained."

"By measuring with the stang planimeter its keel produces two marks on the paper; the distance between these is measured on an ordinary scale by help of a pair of compasses. As the area is equal to this distance multiplied by the length of the instrument, you see that, if this length is one foot, the distance gives directly the area in square feet; if you give the instrument double or half the length, the distance between the marks will give respectively the half or the double of the area; when it is desired to measure an area that is very little in proportion to the length of the instrument, the distance between the marks is so small that it can scarcely be measured accurately enough on the scale; the fault in per cent. grows as the distance diminishes, but this inconvenience may be removed by circumscribing the area two or more times before the end mark is set, as is indicated in the short explanation that accompanies every instrument. If, on the contrary, an area be measured whose dimensions greatly exceed the half length of the instrument, the error of the formula will be serious and in a much increasing degree, when with greater and greater areas, so that at last the result grows totally erroneous. This inconvenience can only be removed by dividing the area and measuring the separate parts. If areas of very different sizes are to be measured, either two instruments of different length must be used, or the somewhat longer process necessary in order to remove the one or the other inconvenience must be followed.



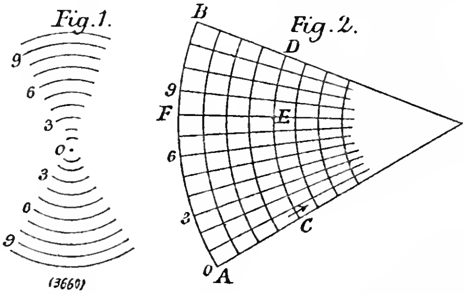
"Last year Coradi, in Zurich, showed me a stang planimeter with a wheel instead of a keel; the wheel could be moved along the stang, but he allowed that the original simple form was the best and surest. Mr. Scott has adopted these two transformations; but I must remark that, when the edge of the keel is grown dull, it is easy for any one to sharpen it a little. A wheel must ever be more sensible to dust and rough usage, and the more, the sharper and more accurately constructed it is. As for area-measuring, there can be no imaginable cause to have a changeable length of the stang; and, as to measuring the mean height, I also prefer the constant stang, and transferring the result on a scale by one of the usual ways, as on the figure above, where *a* is the constant length of the stang, *b* the basis of the diagram, *m* the distance between the marks made in the paper by the keel, p_1 and p_2 two parallel lines, and *h* consequently the mean height, *a m* being like *b h*.

"In the above-mentioned transformations there is nothing opposed to the theory of the instrument; but not so with the celluloid plate that Mr. Scott proposes instead of the tracing-pointer. When this instrument rests something more on the one or the other side of this plate, you will measure the area circumscribed by this or these resting-points, and not the desired area. There is no guarantee that these areas are not of different sizes; it must, therefore, be most undesirable to change the tracing-pointer into a flat plate. It is better to accustom yourself to the management of the pointer as it is, and this presents no difficulty that is not to be overcome.

"The recording-discs that Mr. Scott fixes to the instrument have nothing to do with its working, provided the weight is equal on both sides of the instrument. It is an ingenious invention, but not new. I would prefer to have a graduated plate for the keel to slide upon. Cornelius Knudsen, in Copenhagen, the manufacturer of the original stang planimeter, is about constructing such a plate, where you may read immediately the wandering of the keel in straight line.

"I wonder why Mr. Scott puts his name to the instrument instead of mine. He has on no point changed the principles for its use as a planimeter, and all the 'improvements' that he proposes are not new."

With reference to the tracing-points of the Goodman instrument, Captain Prytz says their form is bad, and that, if Professor Goodman "had done as his colleague at Stuttgart, Professor Hammer, had,"—that is, "examined first an original planimeter (see *Zeitschrift für Instrumentenkunde*, 1895, März, Berlin, page 90),—he would no doubt have found that there was not at all cause to alter the form of the instrument, which for areas from $\frac{1}{20}$ to $\frac{1}{8}$ of the square of the planimeter length, according to the numerous experiences of



Professor Hammer, gives an error less than 1 per cent. Further, if Professor Goodman had examined closer the theory of the instrument, he would have found that $R^2 = \frac{1}{18}(a^2 + b^2 + c^2)$, when the area is a triangle with the sides *a*, *b*, *c*, and that $R_2 = \frac{1}{6} d^2$, when the area to be measured is a rectangle with the diagonal *d*; when this rectangle grows thinner and thinner, *d* approaches to the greatest side *a*; and, when the area has become a straight line *a*, is $R^2 = \frac{1}{6} a^2$, and the correction $\frac{R^2}{4p^2} = \frac{a^2}{24p^2} < \frac{1}{96}$, or about 1 per cent., when you observe the due proportion between area and planimeter; so you will see that the Goodman correction, where R is ever taken from a circle, is totally illusive; the best correction for $\frac{R^2}{4p^2}$ is that given in the construction of the original instrument, whose length, you will observe, differs a little from the declared length.

"I must counsel the engineers, rather than use the 'improved stang planimeters,' to let a country blacksmith make them a copy of the original instrument, and, if they wish to avoid measuring or calculating after a common rule, then, themselves, to draw on the paper whereupon the keel glides a scale, as on Fig. 1, for area-measuring, and, as Fig. 2, for middle-height measuring. The arrow in Fig. 2 indicates the direction of the stang. The chord A B = length of the planimeter; C D = length of the diagram; C = first position of keel; E = last position of keel; A F = middle height of the diagram. C D. A F = A B. C E."

The Practical Limit of Steam Pressure in Engines.

It were premature to aver that this limit has been already reached; but we believe that most competent engineers think it has been nearly approached. Our able cotemporary, *The Engineer* (London, Sept. 25), editorially discusses the likelihood of increase in the working pressure of steam, its remarks being in the nature of a reply to a number of correspondents urging the use of higher pressure. One of these advocated even a pressure of one thousand pounds per square inch, believing that the employment of this pressure would reduce coal consumption to considerably less than one pound per h.-p. hour.

There appears to be in the minds of some a disposition to give the reduction of fuel-consumption for power-production an undue importance. This importance it has held until recently, and reasonably so; but coal-consumption has now been reduced to a figure such that a saving of a considerable percentage would be of small pecuniary importance, if it were gained at the expense of other things also essential.

Suppose that we ultimately reach a point where all large steam-power installations use not more than one pound of coal per h.-p. hour, and that, by carrying higher pressure, we could generate one horse-power with nine-tenths of a pound of coal. With an engine of one-thousand horse-power we could thus save one-half a ton of coal in a ten hours' run. A ship with engines of ten thousand horse-power would save twelve tons per day, so that an Atlantic liner would need to carry and consume about seventy tons less per trip. The cost of this coal, plus the receipts for carrying seventy tons of paying freight, would represent the credit side of the account; the debit side would include increased hazard, increased repairs, greater skill in attendance, more wear and tear, greater fixed charges, etc. We submit that, when increase of debits equals the gains, the practical limit will have been reached. Perhaps it may already have been reached,—a fact which it may take some time to demonstrate. *The Engineer* says:

"Among practical ship-owners there is a growing disposition to run up pressures. Instead of the normal 160 pounds, we constantly hear now-a-days of 180 pounds, 200 pounds, and even 225 pounds. Between this last, however, and 1,000 pounds there is still a great gap, which will not be crossed in a hurry. But it will not be out of place, perhaps, to direct attention to certain facts which, it seems, are in danger of being forgotten.

"The ship-owner cares nothing at all for the consumption of coal per h.-p. per hour. His interest in the machinery of his ship begins and ends with the aggregate sum he has to pay for conveying a ton of goods any convenient unit of distance,—say, 100 miles. Now, this price paid covers not only coal, but many other things as well. The ship-owner knows that his boilers and engines depreciate so rapidly that it is not safe to allow less than 15 per cent. per annum on the first cost for depreciation and interest. Then lubrication is an important item; so are the wages of the engine and boiler-room staffs. It is true that, by augmenting pressures and ratios of expansion, coal may be saved; but, on the other hand, it is possible that the whole saving may be swallowed up by augmented expenses peculiar to extreme pressures."

An example of some of the minor difficulties in the carrying of high-pressure steam is the impossibility of obtaining suitable glass gages. "Jacob Perkins was compelled to use talc instead of glass, and this made a very unsatisfactory gage. The glass softens or decomposes rapidly, and loses its transparency. This is one reason why so many patents have been taken out for electric gages and low-water detectors. It ought, of course, to be possible so to scheme a gage that it will always be cool, in much the same way that a pressure gage is kept cool; but this has not been done yet. Another difficulty lies in the furnaces. Their diameter must be kept down, and this gives a contracted fire-space. Of course water-tube boilers may be used, but they have not yet established their reputation in the mercantile marine; and we write now of things as we have them, not as they may be in half-a-dozen years. Another trouble is found in the manhole packings, in the feed-pumps, and in every cock and joint about the boiler, from the steam whistle up. These difficulties are not insurmountable, but to get over them entails outlay. This is the fact on which we wish to insist. Every one, in short, who has had any experience with high-pressure steam knows that it is a very different thing from low-pressure steam; and that, whereas its sole virtue is that it saves coal, its many defects may very easily make the ship-owner regret that he ever adopted it."

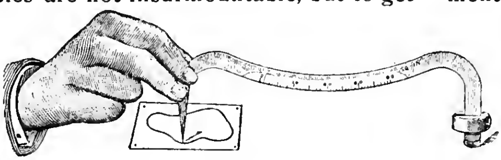


FIG. 1.

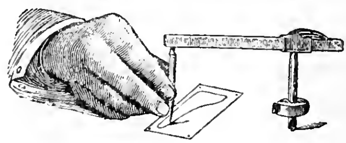


FIG. 2.

Fig. 3.

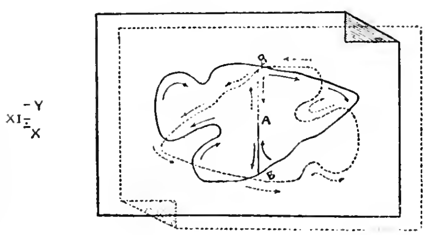


Fig. 4

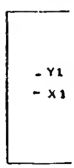
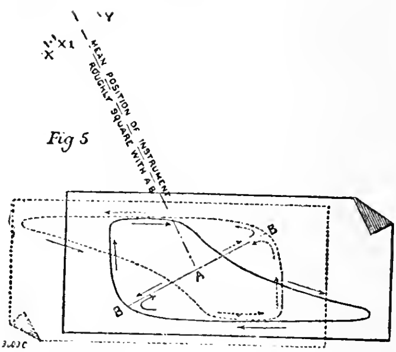


Fig 5



GOODMAN'S HATCHET PLANIMETER.

Another Improved Planimeter.

ATTENTION to the subject of planimeters has been recently aroused in the mechanical world by the publication of alleged improvements. One of these (Scott's—so called) was illustrated and described in this department for October, and we herewith present a review of an illustrated description of another form, devised by Professor Goodman of Leeds (*Engineering*, Aug. 24). The "hatchet" planimeter, otherwise called the "stang" planimeter, was, as stated in our October number, invented by Captain H. Prytz of Aarhns, Denmark. The publication of Mr. Scott's article and the description of Goodman's planimeter have called out two interesting letters from Captain Prytz, printed in *Engineering* (Sept. 11), and noticed elsewhere in this department. We herewith present a reduced engraving of Professor Goodman's instrument, and a condensed descriptionof it.

There are two forms of the instrument, one used for measuring areas and surfaces, and the other for measuring the mean height of diagrams.

"The method of using the two instruments is practically the same. In order to familiarize one's self with the peculiar action of the instrument, it will be well to get a large sheet of paper on a drawing-board or a large blotting-pad, and, holding the instrument vertical to the paper, grasp the tracing leg very lightly indeed between the forefinger and thumb of the right hand, with the hatchet toward the left hand, as shown in Fig. 1. Then by moving the tracing-point round and round an imaginary figure, and allowing the hatchet to go where it pleases, it will be seen that the hatchet moves to and fro along zigzag lines, and travels sideways,—the side travel being nearly proportional to the area of the figure described by the tracing-point. If the tracing-point be too tightly grasped, the hatchet will not move freely, and will have a side slip. When this occurs, the side travel of the hatchet ceases to be proportional to the area traced out. A loose weight is hung on the hatchet to prevent this side slip, but, with a little skill, this weight may be dispensed with.

"When measuring the area of a surface like that shown in Fig. 3, a point, A, is chosen somewhat near the center of the figure; the exact position is, however, immaterial. From the point, A, a line, A B, is drawn in any direction to the boundary; the tracing-point of the planimeter is now placed at A, with the hatchet at X, Fig. 3,—that is, with the instrument roughly square with A B. The hatchet is now lightly pressed, in order to mark its position on the paper by making a slight dent; then, leaving the hatchet free to move, as shown in Fig. 1, the tracing-point is caused to traverse the line, A B, and the boundary line in a clockwise direction, as shown by the arrows, returning to A *via* A B. The hatchet will now be found to have taken up a new position, Y, which must be marked by again pressing the hatchet to make a slight dent in the paper. If the figure under measurement be on a separate sheet of paper, the paper must now be revolved about the point, A, through about 180 deg. (by eye), using the tracing-point of the instrument as a center, care being taken that neither the point nor the hatchet be shifted while the paper is being turned. The line, A B, will again be roughly at right angles to the instrument, but in the reverse direction (see dotted lines in Fig. 3). Again cause the tracing-point to traverse the line, A B, and the boundary line as before, but this time in a contra-clockwise direction. The hatchet after this backward motion will take up the new position, X_1, which may or may not coincide with X; if not, prick a central point between X and X_1, as shown; then, of course, the distance of this point from Y is the mean side shift of the hatchet; this distance measured from the zero of the scale on the back of the instrument is the area of the figure in square inches. The scale is read in exactly the same manner as a geometrical scale on a drawing, the whole numbers being read to the right of the zero and the decimals to the left. The instrument does not profess to give results nearer than one-tenth of a square inch.

"When the figure is too large to be conveniently turned, the instrument itself must be turned through 180°, and two fresh dents, X^1 Y^1, obtained. The mean of the two readings, X Y, X^1 Y^1, will be the area sought.

"If, in large figures the instrument be out of square with A B at the finish, it is necessary to see that the mean position be square with A B. The scale is made with regular and increasing divisions, which compensate for errors that otherwise would have to be taken into account, and which add greatly to the labor of computing the area with exactness."

The relative accuracy of this planimeter, compared with Ammsler's, and with other methods, is exemplified in the following table:

Method.	Measurement of Areas Reduced to 100.
Amsler planimeter	100
Goodman "	100 + or — 0.6
Simpson's rule	100 + or — 1.0
Mean ordinates	100 + or — 2.4
Cutting out in cardboard and weighing against piece of known area	100 + or — 4.4
Equalizing curved edges by drawing straight lines along boundary and calculating by triangles	100 + or — 7.0

In the instrument for getting mean heights of figures, the length of the instrument between the hatchet and the pointer is variable. The length is set to the length of the diagram (see Fig. 2); it is then used in precisely the same manner as the planimeter described. The diagram in Fig. 5 will be clear. The mean distance between the dents is in this case the mean height of the diagram, measured on an ordinary scale, or the mean pressure in the case of an indicator diagram measured on a scale to suit the indicator spring. The method of correcting the instrument by increasing divisions of the scale is approximately correct for all lengths of diagrams, the error being well under one per cent.

New Departure in Boat-Building.

THE manufacture of dwellings in such manner that their parts may be sent packed separately and assembled at the point of erection has been successfully carried on for a considerable period. A similar system, described in the *American Shipbuilder* (Oct. 8), has been applied to the manufacture of boats by a St. Louis boat-builder.

"When furnished with the size of boat that is desired, he gets out the material, fastenings, etc., all ready to put together, and ships them to the purchaser to build the boat with. The main object in supplying boat-building materials is the great amount of money saved in freight charges. For instance: the freight charges from St. Louis to San Francisco on a completed hull weighing 2,000 pounds would amount to $250, while the materials for the same hull (minus the planking), all cut and bent to exact proper shape, crated, would weigh 1,100 pounds, and would reach the same point at an expense of $11 for freight. The same shipment from St. Louis to New York would amount to $77.80 and $10.67 respectively, the eastern rates being higher than the western. This immense difference in charges of transportation allows the purchaser to build a hull under his own supervision for less money than the difference in freight charges. The only other advantage is that, in purchasing a frame, the buyer gets at the same time a model, which is the most important item in constructing a hull.

"The launch frames are said to be made entirely of best selected Arkansas white oak, and consist of keel and keelson all shaped up and spliced and fitted to bow-stem and sternpost. All holes for bolts bored; bow-stem babbeted to receive planking and fitted to keel; round stern transom cut from solid planks and fitted to stern-post; garboard and sheer strakes and all timbers (or ribs) steam bent to proper shape; every part of frame completely marked; the whole accompanied by a sheet of plain instructions, so that any one of ordinary ability can set the frame up ready for planking."

The enterprising builder of these boats will doubtless get an extensive patronage, but, having set the pace, he can hardly escape competition. The possibility he has discovered will soon draw others into the field.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

*8127. Six Examples of Successful Shop Management. Ill. Henry Roland (Showing in this instalment the conditions of labor employment in the Whitinsville shops). Serial. 1st part. Eng Mag-Oct. 4200 w.

*8165. Core Prints. Herbert Aughtie (How core prints ought to be made for different positions and uses). Prac Eng-Sept. 4. 1000 w.

8361. Tool Room Equipped from the Scrap Pile—Substitute for Chalk—Book of Blueprints—Belt Diagram. S. T. Freeland (Practical hints upon topics named in title). Am Mach-Sept. 24. 2000 w.

8364. Cabinets for Drawings. William H. Derbyshire (A design for cabinet, used in the works of Bement, Miles & Co). Am Mach-Sept. 24. 100 w.

8365. Tool Room Management (A paper read before the "Advance Club," Dayton, Ohio, by Joseph Kelly, assistant foreman of the tool room of the National Cash Register Co. Drawings for tools as usually made are criticised. Comment by editor of *American Machinist*). Am Mach-Sept. 24. 1000 w.

8366. How to Turn Out Good Molders. D. F. Matlack (Read at the Philadelphia meeting of the Am. Foundrymen's Assn. In apprentices, fitness, industry and intelligence should be rigorously recognized). Am Mach-Sept. 24. 700 w.

8367. Old and New Methods in Boiler Making (The methods of thirty years ago are contrasted with the improved methods of to-day, and some fine examples of marine boiler work are named and briefly described). Am Mach-Sept. 24. 2500 w.

8406. Charging Cupolas. E. Grindrod (A plain, practical talk by a practical man who has reasons to offer for each detail of practice). Foundry-Sept. 700 w.

8407. Cupola Practice. H. M. Ramp (Personal opinion based on experience. First part reviews recently published articles by leading foundry men). Foundry-Sept. Serial. 1st part. 1500 w.

8409. Compressed Air and its Economies in the Foundries. Curtis W. Shields (Full text of paper read before the Sept. meeting of the Western Foundrymen's Assn. The various applications of compressed air in foundry work and the advantages resulting are set forth). Foundry-Sept. 3300 w.

8410. Making Clean Castings (The necessary safeguards to prevent dirty castings are stated). Foundry-Sept. 800 w.

8557. Laying Out a Worm and Worm Gear. W. L. Cheney (The nature of a worm gear and the proper method of laying it out to secure satisfactory results). Mach-Oct. 2200 w.

8559. Machinists' Piece Work. M. S. Link (The piece work system, while admitted to place workmen in their highest working capacity, is condemned as gradually extinguishing the grade of good all-around machinists). Mach-Oct. 1500 w.

8639. Bevel Gear Curves. H. W. Alden (A table, or set of curves, to cover all ratios, with explanatory text). Am Mach-Oct. 8. 1000 w.

8640. A New Lathe Chuck. F. A. Halsey (Illustrated description of work done on a new chuck having a wide range of capacity, and designed by M. A. Sangster, foreman of the Canadian Rand Drill Co). Am Mach-Oct. 8. 800 w.

Steam Engineering.

8245. Caring for Steam Cylinders and Pistons. W. H. Wakeman (Practical hints derived from authority and experience). Safety V-Sept. 2800 w.

*8290. The "Universal" High-Speed Engine (Results of tests). Engng-Sept. 11. 1000 w.

*8322. The Raworth "Universal" Steam Engine (Illustrated description and an account of tests and results). Elect'n-Sept. 11. 700 w.

8391. The Most Economical Cut-off for Steam Compression. Henry T. Eddy (Abstract of a paper read before the Amer. Assn. for the Advancement of Science. The conclusion is reached that for maximum economy the cut-off must be such that the ratios of expansion and of compression shall be equal). Elec Wld-Sept. 26. 900 w.

8424. Effect of the Rate of Combustion Upon the Efficiency of Steam Boilers (Editorial review and critique of a paper read by Prof. W. F. M. Goss of Purdue University, before the New York Railroad Club. The paper is regarded as an important contribution to the literature of steam engineering, but exceptions are taken to some of the statements). Eng News-Sept. 24. 2800 w.

8457. State Inspection of Boilers in Massachusetts. From a paper by Thomas Hawley (A review of the Massachusetts law and how it is working). Bos Jour of Com-Sept. 26. 2400 w.

8519. Steam Boiler Practice in Europe (Extracts from the report of Mr. R. S. Hale, in Circular No. 5, of the Steam Users' Assn., on current European practice, based upon personal inspection). Eng News-Oct. 1. 3200 w.

†8540. On the Rate of Condensation in the Steam Jet. A. de Forest Palmer, Jr. (Illustrated description of apparatus, method employed, and results attained in an experimental investigation of the subject named). Am Jour of Sci-Oct. 2500 w.

8553. A Method of Determining the I. H. P. of an Engine Under Varying Load. W. H. Macgregor and R. T. Kingsford (Investigation of the power required to operate an Otis electric elevator, with diagrams). Power-Oct. 1000 w.

8555. The Blowing Out of Boilers. W. A. Carlile (Proper purpose and methods of blowing out boilers). Mach-Oct. 1200 w.

8558. Friction Losses and Oiling Systems for Steam Engines. E. T. Adams (Losses of engine power through friction and reduction of these losses through methods described and illustrated). Mach-Oct. 2400 w.

8560. An English System of Forced Draft. James Vose (Illustrated description of the "Meldrum" dust fuel and forced draft furnace for steam boilers). Mach-Oct. 1400 w.

8583. Steam Making. Winthrop Thayer (Paper read at meeting of New England Cotton Mfrs. Assn. The writer gives his views of the essentials of economical steam making). Bos Jour of Com-Oct. 3. 3000 w.

†8584. Heat-Wastes in Steam-Engine Cylinders. Robert H. Thurston (Abstract of paper read before the British Inst. of Naval Architects at its session in 1895. A condensed statement of the theory of heat wastes in the steam engine cylinder). Jour Fr Inst-Oct. 6000 w.

8629.—$1.50. Description and Computation of Twenty-four Hour Duty Test on the Twenty Million Gallon Leavitt Pumping Engine at Chestnut Hill. Edward F. Miller (Illustrated description of engine with extensive tabulated data). Tech Quar-June-Sept. 6000 w.

8651. Indicator Practice. A. C. Lippincott (Illustrated dissertation of a practical character, dealing chiefly with reducing motion devices). Lord's Mag-Oct. 1200 w.

Miscellany.

8143. The Efficiency of Pelton Water-Wheels. F. K. Bloue (A method of finding deficiencies and faults in connections and settings which interfere with the normal efficiency of a Pelton wheel. Notation and formulæ employed and interpretation of results). Elec Wld-Sept. 12. 2500 w.

*8168. Steam Locomotion on Common Roads. W. Fletcher (Illustrated description of the lighter types of road locomotives, and a comparison of their merits with those of the larger traction engines). Eng, Lond-Sept. 4. 4200 w.

*8177. Table Mountain Wire Ropeway (Illustrated description). Engng-Sept. 4. 700 w.

*8183. Flax Scutching and Flax Hackling

Machinery. John Horner (Illustrated detailed description of machines used, their operation, and the processes to which the flax is subjected from the raw state till fitted for market as "dressed line"). Engng-Sept. 4. 5400 w.

8241. Smoke Prevention from a Mechanical Standpoint. C. H. Benjamin (General remarks upon existing methods). Can Eng-Sept. 1500 w.

8247. Credit for Shop Experience in Entrance Examinations (General editorial remarks upon the subject, with reference to previous editorials and to replies from seventeen technical schools in reply to a circular letter inquiring what their practice is with reference to this subject). Am Mach-Sept. 17. 1800 w.

8285. The Manufacture of Radiators. H. Hausen (Illustrated detailed description). Heat & Ven-Sept. 15. Serial. 1st part. 2200 w.

*8294. The Prytz Planimeter (Letters from H. Prytz, criticising some points in the planimeter as recently improved by Scott, and claiming that Scott is not the inventor of improvements claimed by him). Engng-Sept. 11. 1300 w.

8307. Steel Tubes. H. K. Landis (The use and strength of steel tubes, with brief description of process of making). Am Mfr & Ir Wld-Sept. 18. 900 w.

8357. The Compressed Air Power Plant at Jerome Park, N. Y. (Illustrated description). Com Air-Sept. 1400 w.

8370. Goodman's Hatchet Planimeters (Illustrated detailed description). Sci Am Sup-Sept. 26. 2000 w.

8373. Compressed Air as a Hoisting Power in the Foundry. George A. True (Read before the Western Foundrymen's Assn. Description of plant required for a foundry of thirty tons daily output,—details illustrated,—and a general review of the advantages of such an installment in foundry work). Ir Age-Sept. 24 3600 w.

*8401. The New Russian Patent Law (Statement of the principal provisions of the law). Mach, Lond-Sept. 15. 800 w.

*8414. The Motor, or Horseless Carriage. James Long (The first part deals with existing obstacles to the use of the horseless carriage in the United Kingdom. The series will present descriptions of the best types of motor carriages). Ind & Ir-Sept. 18. Serial. 1st part. 2000 w.

8434. Long-Distance Power Transmission (Brief illustrated description of one of the most important examples of power transmission yet undertaken. Power transmitted from Ogden, Utah, to Salt Lake City—six miles of water pipe and 36 miles of electric wire). Ry Age-Sept. 25. 1000 w.

*8458. The Horseless Carriage of the Future (Editorial. Problems connected with horseless carriages and their present status). Eng, Lond-Sept. 18. 1200 w.

*8461. The Moving Sidewalk Railway at the Berlin Industrial Exhibition, 1896 (Illustrated description). Eng, Lond-Sept. 18. 1500 w.

8498. Making Balls for Bearings Horace L. Arnold (Full, illustrated description of method and appliances). Am Mach-Oct. 1. 4500 w.

8500. Tacks and Tack Dies. J. L. Lucas (Illustrated description of the Blanchard tack machine, and the method of cutting tacks from sheet metal). Am Mach-Oct. 1. 700 w.

8520. Pneumatic vs. Iron Tires for Vehicles (Abstract of article in *Le Genie Civil.* Historical. Illustrated). Eng News-Oct. 1. 500 w.

8556. At the Worcester "Tech." (Illustrated description of mechanical engineering equipment). Mach-Oct. 600 w.

8563. Power Transmission. F. H. Underwood (A paper read before the Profile meeting of the New England Cotton Mfr. Assn. A general dissertation upon power transmission in a modern mill, say of 400,000 spindles, operated by steam power). Eng Rec-Oct. 3. 1000 w.

*8569. Quick-Firing Field Guns (Illustrated detailed description). Eng, Lond-Sept. 25. 2000 w.

*8570. Report of the Screw Gauge Committee of the British Association (Exhaustive, with a tabulated statement of screws recommended, and appendix with diagrams, and descriptions of shadow photographs of screws. Also appendix on gauges for verifying accuracy of screws, and another giving working dimensions in millimeters, and in thousandths of inches). Eng, Lond-Sept. 25. 3000 w.

*8572. Address to the Mechanical Science Section of the British Association. Douglas Fox (Review of mechanical progress in the leading industries of the world, and in various branches of engineering). Eng, Lond-Sept. 25. 9800 w.

†8586. Niagara on Tap. T. Commerford Martin (Illustrated description and general remarks upon the utilization of the power of Niagara Falls by the conversion of the energy of its fall into electricity). Jour Fr Inst-Oct. 4500 w.

8623. Power Transmission by Vertical Shafts in a High Building (Illustrated description of power transmission by means of vertical shafts extending from the basement to the top floor). Ir Age-Oct. 8. 700 w.

8631.—$1.50. Tests on Bolted Joints (Illustrated description of eight tests made in the laboratory of the Massachusetts Institute of Technology, with tabulated data). Tech Quar-June-Sept. 1800 w.

8637.—$1.50. Torsion Machine, and Tests of Torsion (Description of a new measuring apparatus applied to the torsion machine of the Mass. Inst. of Tech., and tabulated torsion data for a variety of materials). Tech Quar-June-Sept. 3500 w.

8638.—$1.50. Rope Tests (Tabulated data obtained in the laboratory of the Mass. Inst. of Tech., with a variety of ropes and splices). Tech Quar-June-Sept. 250 w.

8644. Gray Iron Work and Malleable (From the *Iron Molder's Journal.* Some difficulties encountered by those who go from the gray iron into general jobbing on malleable iron, with suggestions as to best method of disposing of them). Ir Tr Rev-Oct. 8. 1000 w.

MINING & METALLURGY

Carelessness and Mining Accideuts.

In reviewing the record of casualties for 1895 in the Pennsylvania mines. *The Colliery Engineer and Metal Miner* finds "the usual proportion of fatal accidents largely attributable to the recklessness or carelessness" of the victims. It admits that this is "rather a harsh criticism to make on the poor fellows who lose their lives in the coal mines, but it must be made, and the dangers must be pointed out, if a remedy is to be secured."

To establish the case as alleged against the miners, quotations are made from the reports of the inspectors in many districts, both in the anthracite and bituminous fields.

"Mr. Edward Roderick, inspector of the first anthracite district, in commenting on the one hundred and sixty accidents (fatal and non-fatal) that occurred in his district, says that seventy-six were caused by falls of coal and rock. Some of the deaths caused by falls were, he states, undoubtedly purely accidental, but the greater number of them were the results of direct or indirect recklessness, as is proven by an examination of his detailed report. The number of men who were killed during the year by going under a portion of roof which they had been trying to pull down just a few minutes previous to its falling is remarkable.

"These accidents cannot, at all times, be attributed to the ignorance of the victim, for in many cases during the year intelligent miners have been killed in this way. Oftentimes, after firing a shot, men go back to the face of their working-place, sound the roof, and find it somewhat loose. As they say, 'It is not loose enough to fall yet, and we will keep an eye on it.' With this remark they proceed to work in the face, when it is their imperative duty to first secure the roof. So long as men continue to work in this careless and thoughtless manner under dangerous and loose pieces of roof, just so long will the record of these accidents occur.

"In commenting on mine accidents in his district, Mr. G. M. Williams, of the fourth district, says: 'It has been repeatedly stated that most of the mine accidents take place owing to the carelessness of the victims, and thus an impression has been created that the underground workers are less careful than employees in other industries. The assertion that the greater number of the mine accidents are due to carelessness is certainly correct, but it is not fair to say that the mine workers are more careless than men generally are in proximity to danger.'

"Mr. William Stein, of the sixth anthracite district, is of the opinion that mine accidents under present systems of working can be reduced at least eighty per cent. He calls attention to the fact that, of the fifty-six fatal accidents in his district in 1895, forty-seven were due either to carelessness or a lack of knowledge as to the safety of working-places; three lost their lives through the neglect of a fire boss in allowing the victims to enter their place of work before first removing the gas; the remaining nine accidents he considered purely accidental. Forty-seven who lost their lives chose themselves to take unusual risks while in the performance of a day's work, and their reasons for so doing can only be presumed.

"Mr. William Jenkins, of the second bituminous district, says: After careful investigation of all the fatal accidents, I find that fourteen men were killed from carelessness on their own part.'

"Mr. Thomas K. Adams, of the third bituminous district, reports but seven fatalities in his district during the year, but of these seven he states that at least two resulted from gross carelessness. Both of the victims had been warned of their danger just previous to the accidents which killed them; both had been warned of the dangerous condition of the top and advised how to proceed; but in both instances the friendly counsel was not heeded.

"Mr. Charles Connor, of the fifth bituminous district, in commenting on the accidents in his district, says: 'It is an unpleasant duty to have to report year after year the same old story,—that a large number of the accidents were the result of carelessness either on the part of the injured parties themselves, or of some other person,—and yet this is too true. Seven of the thirteen persons who were killed during the year would have been alive to-day if they had exercised even ordinary care to protect their lives, while two of them met their death through the carelessness of others; thus only four of the fatalities can be properly said to have been accidental, the others being the result of contributory negligence, either by themselves or others.'

"Mr. James Blick, of the seventh bituminous district, says: 'Of the whole number of deaths from falls of slate (12), only about five can be classed as purely accidental; five others could have saved themselves if they had exercised proper care; and at least two came to their death because they were not familiar with the methods of self-protection.'

"Mr. Joseph Knapper, inspector of the eighth bituminous district, says: 'In the reports of accidents, both fatal and non-fatal, there are shown several cases of gross carelessness, whereby the victims exposed themselves to falls of coal and roof when they knew that danger existed.'

"Mr. Bernard Callaghan, of the ninth bituminous district, commenting on the accidents in his district, says: 'Some of the accidents were remarkable, while some were the direct results of neglect. The greater number of the miners killed were Americans or other English-speaking people, so that ignorance of the language and of the mining laws cannot be blamed for their unfortunate end. The only advice that can be given is a caution for constant care and faithful observance of the mining laws. When men learn to value their lives more than the price of a wagon of coal, the mine will have lost its death-record.'

"Mr. R. Hampson, of the tenth bituminous district, in commenting on the accidents in his district, says: 'The number of fatal accidents is much greater than that of the preceding year, and, on examining into the causes of them, it was found that four of them were attributable to falls of coal and roof, and those killed by falls of coal had neglected, in each instance, to set sprags while undermining coal, and in two of the cases the coal had already been loosened by a previous shot, and in the other there was a slip running through the coal to the roof, while, in the case of the man killed by fall of roof, he was negligent even to foolhardiness, for he was repeatedly warned by his fellow-workmen to come out of the place until the roof had settled, but he told them "he knew when it was dangerous, and when to come out." It is sad to reflect on the above accidents, which in every case could have been averted, had each one taken the necessary precaution for his safety, and obeyed the rules laid down for his guidance, for it is only by following out the rules that such accidents can be averted.'"

It is from Mr. Hampson's suggestions (which are echoed by many of the other inspectors) that *The Colliery Engineer* takes the text for its preachment.

"It is evident from the above that a rigidly-enforced discipline is necessary in the coal mines of Pennsylvania. With our jury system it is almost impossible for a mine inspector to secure the conviction of a working miner who violates the mine laws. There are two reasons for this; one is that the violator of the law is frequently the victim of the accident, and, if not killed, is severely injured, so that all classes of the community consider him sufficiently punished for his carelessness and disobedience of the law. Another reason is that the average jury does not understand the technicalities of mining, and they sympathize with the poor unfortunate who has been prosecuted for disobeying what to them seems a trivial provision in the mine law. This and sympathy for the miner result in his immunity from punishment.

"If, under our constitution, it was possible for the mine inspector to order the arrest of a miner caught violating the law, have him taken before a justice of the peace and fined or imprisoned, the law could be better enforced, but, under the constitution of Pennsylvania and the various mining States of the union, such a procedure would be illegal, as every man has a right to trial by jury."

This *is* unfortunate; but, as the *Colliery Engineer* says just above, the offence often becomes apparent only through the death of the offender, and, after that event, even denial of the right to a jury trial has little terror for him.

It is unfortunately but too probable that Mr. Callaghan comes nearer to the heart of the matter,—"the price of a wagon of coal." Under the tonnage system of payment which prevails throughout the region, nothing but merchantable coal at the tipple means any money to the miner.

Suspension of shipping facilities and developments of the operators' policy make the duration of work very uncertain; few have claimed that the rates of payment are highly remunerative at the best.

Is it any wonder that every wagon of coal is coveted, and important, but profitless, work neglected on the chance that all will go right, and a few more tons of the wage-bringing coal be placed to the miner's credit instead.

No doubt the men are often criminally reckless; no doubt, like other workers in dangerous occupations. Many of them would take needless risks under any system, unless restrained by a strong hand; but, when the same story comes with so terrible similarity from all over the field, it suggests a more general and deeper-lying cause.

"The price of a wagon of coal" means too much. It is possible (with all deference to *The Colliery Engineer* in the proposal of a remedy) that "intelligent miners" who "knew that danger existed" and still took the chance of death for a slight increase of earnings might still take the chances of the law, jury or no jury, under the same pressure.

Poverty is a strong tempter. A sort of desperation is generated by want, which creates indifference to personal risk, and has sacrificed many lives.

Free Coinage—and What Next?

In Mr. Tait's excellent article on the silver question, in the September number of The Engineering Magazine, occurred the significant words: "There has been no talk, up to the present time, of issuing certificates against the deposits for coinage."

The expression recognized a possibility which Mr. Tait, no doubt properly, considered it premature to consider in a criticism of the present position and demands of the free-silver party; but that this would be the next step is beyond all question, and the course is already being conjectured by the press and its bearings considered.

The situation is thus outlined by the *American Manufacturer:*

"The superintendent of the Philadelphia mint has made an important statement to the effect that, if a free-silver-coinage law should be enacted at this time, it could not be enforced. He points out that it would be a physical impossibility for the government to coin the silver which, under the provisions of such a law, would be dumped into the mints. The government vaults now contain 200,000,000 ounces of silver bullion, and, at the present minting capacity, it would require five or more years to coin this into money before an ounce of the bullion which would be poured in under a free-silver law could be touched. The superintendent claims that ten years would be required to increase the capacity of the mint, during which time bullion would be accumulating in such quantities that the mints would never be able to use it up. The answer of the average silverite may be anticipated. He wants the government to provide storage for vast accumulations of bullion, and then issue silver certificates to the coinage value of the bullion, at a ratio of sixteen to one. Really he does not want silver at all. In fact, he would rather not have it. He wants paper."

There is no kind of question that this defines correctly the future attitude of the vast majority, at least, of the silverites, should their primary demand for free coinage prevail. The inflationists who are possessed by the conception that prosperity is contingent upon the volume of currency—an idea about as logical as the assumption that the wheat market depends on the number of bushel measures in the country—will naturally proceed to inflate the volume as rapidly as possible, so as to "hasten the dawn of prosperity." The silver-owners who are seeking an unlimited market will rebel at the limitations which would be enforced by the delays of coinage, unless, indeed, a few of the wiser ones should share, with the same element of the community, the perception that the invited deluge would utterly break down the market and overwhelm them, with the country at large, in the river of a demoralized and discredited currency.

More Cyanid Litigation Threatened.

THE cyanid patents, which Dr. Wells's able article in the August number of THE ENGINEERING MAGAZINE showed to have so little claim for protection in the light of the plain testimony of history and experiment, appear to be having a hard struggle to establish their validity the entire world around.

The settlements reached in this country are understood to be wholly of the nature of a compromise, and, until the case has been fully presented and decided by the higher courts, the claimants' contention must be considered at least "not proven."

The following clippings from the *Australian Mining Standard* show that the agitation is beginning at the antipodes, and that the patentees are likely to have a rough road to travel before the validity of their rights will be unquestioningly recognized by the mining world.

The cyanid process has been the subject of questioning in the New South Wales assembly. The Hon. Sydney Smith, minister for mines, in answer to Mr. Willis, said that he was aware that certain persons in New South Wales claimed to hold a patent right for working what was known in mining as the "cyanid process" of recovering gold from ores. He understood that a heavy royalty was being demanded for treating ores or tailings by this process, and it was a fact that these persons held such patent rights, but the question as to whether they could enforce royalty under these patent rights had not been tested in the colony; probably it will soon be tested. Cyanid has done for gold-mining what it is hoped the sulphid processes will do for silver. Any restrictions on its use are pretty certain to be challenged.

A correspondent from New Zealand writes, with reference to the cyanid process, that that government has written to the Victorian government for reports of the arguments which defeated the Cassel Company's application for an amended patent. These arguments will be used by the government in the counter action to the company's application in the New Zealand court for an amendment of the patent. In the event of the application not being granted, the company will carry the case to the privy council.

Sundry Views of the Tin-Plate Industry.

THERE was a time, not very long ago, when a casual reader of the daily press might easily have received the impression that the future of the American people was bound up in the manufacture of tin plate. The dinner-pail threatened to divide the nation. According to some, the national honor was dragged in the dust with every importation of English tin; according to others, it was sheer fatuity to contemplate the establishment of the industry in this country.

But we have begun to make tin; the sun still rises and sets in the accustomed quarters; and the net result is so unapparent that the press has almost forgotten the discussion, and the mention of tin plate awakens only a fleeting reminiscence.

The lapse of time has been sufficient for the situation to have become pretty clearly defined. It may, therefore, be interesting to compare an English and an American view of the present status of affairs.

The *American Manufacturer* says: "The latest figures on the British tin-plate exports show that there were 13,930 tons of tin plate brought into the United States during the month of July. This is the largest monthly amount reported for this year, exceeding that of the previous month by 2,177 tons, or an increase of about 19 per cent. Compared with July of the preceding year, the figures show a decrease in the exportations of about 12 per cent.

"This marked increase in the amount of tin plate brought into our country from Great Britain is largely to be accounted for by the reduction in the labor cost of manufacture in the Welsh tin-plate districts, from which the greater part of the British tin plate comes. Some time ago the Welsh manufacturers, realizing the fact that their American trade was fast slipping from them, decided to make some decisive move. In conjunction with the workers some considerably reduced the cost of production, and shipped their tin plate at lower figures than ever. In some parts of the trade, however, a strike is threatened, and next month may show lower exports. The tin-plate trade just now, as it has for some time past, is a striking illustration of what the foreign producer can do to hold back an American industry. The prices at which Welsh tin plate is now laid down in New York are extremely low, but with inadequate protection they must be met by American producers."

According to the (British) *Iron and Coal Trades Review*, however, "there is a general impression abroad that the tin plate industry of Great Britain is doomed to suffer a curtailment that will lead to the closing of many mills, and to the deprivation of employment over a large area of labor. We have from time to time pointed out that, so far as the United States are concerned, this has now become almost a foregone conclusion. The tin-plate manufacturers of South Wales, some of whom looked at the matter with a light heart when the McKinley act gave the Americans the chance for which they had long been watching and waiting, are ready to admit so much themselves. Not only so, but they also admit that the Americans have to a certain extent improved the details of the manufacture, and are now in some respects doing actually better work than is being done in South Wales. This is certainly a remarkable change, when we look back upon the conditions that prevailed six years ago, when South Wales had the tin-plate industry almost wholly to herself, and when the Americans were almost ridiculed for supposing that it was within their power to make any progress with an industry that had up to that time been ignorantly and foolishly regarded as a Welsh monopoly.

"Thoughtful men in the trade are now most anxious about its future. Some look upon Canada as likely to expand steadily, and great hopes are entertained of what may be done in British Columbia, but it is important to bear in mind that the Canadian market has already been captured to a large extent by the United States, and that the same result is likely to happen in reference to tin plates. The hope of the trade lies in the east. If the Welsh manufacturers are wise in time, they will send out competent commissioners to look out new markets and press their wares more energetically upon old ones. Thus, and thus only, can they 'hold the fort' in the future."

It is noticeable that the tone on both sides is strongly discouraging—even pessimistic. Looking at the matter broadly, it seems a very imperfect success to have established an unprofitable industry here at the expense of destroying a prosperous one abroad. The greatest good to the greatest number does not seem to have been subserved in this instance. And it is significant that the *American Manufacturer* follows a somewhat familiar precedent in suggesting, as a remedy for the home industry, more protection.

Meanwhile, it will interest all parties to learn of any promised addition to the world's store of tin. The *Australian Mining Standard*, commenting upon recent developments in South Gippsland, says of the "Great Southern tin mine":

"The prospects promise to be highly remunerative, and bid fair to remove the prejudice that Victoria is not a tin-producing country. The Great Southern tin mine is an English proprietary company, and the shares are well held. Nearly the whole of the capital was subscribed in London and France, only a few shares being allotted in Melbourne to persons who had interested themselves in the industry, and were desirous of participating in the development of the field."

The Herring-Bone Method of Timbering.

An article in *The Colliery Guardian* on "The Economical Use of Timber in Mines" contains many excellent hints, both as to methods and means.

A number of the suggestions are applicable chiefly to English practice. The "larger opportunity for greater economy" afforded to mine managers in the possibility of recovering timber from abandoned workings, for instance, is hardly realizable in this country, as yet; for our mines are generally situated in regions where timber is cheaper than labor, and we have not developed the far-sighted economy of forest-preservation.

It is significant of the different conditions prevailing in England that about half of the paper is devoted to criticism of wasteful practice, and suggestions of measures for preserving or recovering timber.

Some excellent advice is given as to the handling of heavy sticks by simple mechanical aids, procurable in any mine; the most interesting part to American miners, however, is the exposition of the "herring-bone method" of timbering, adaptable to any situation where the roof weights particularly in the middle.

"In such places," says the writer, "the ordinary transverse timber has a very short life, owing to the concentrated load it carries."

Left to themselves, such roads "arch themselves" and the "herring-bone" method takes advantage of this circumstance. Any other method is more costly and less reliable, for, whatever the method employed, the roof will assume more or less of this arch form. When the timbering is of the usual transverse kind, the concentrated weight on the middle necessitates its constant renewal, and the middle of the roof continually works itself out. Under such circumstances, the renewal of this transverse timber may be performed in one of three ways. First, the new balk may be put exactly where the old one has come out. The middle of the roof being fallen, such a balk will get a hold at each end only, and other timber must be superposed to support the middle. This superposed timber again transmits the load to the middle of the beam, besides which the over-hanging sides, being either imperfectly supported or wholly unsupported, are dangerously liable to fall away and cause disaster. Or, secondly, having put in the new balks at the level of the old ones, the whole can be lofted with running battens. This will be safer, because the lofting will catch the overhanging sides when they fall; a natural pack will thus be put on the top of the lofting, and the load will be better distributed on the main beam. But such a method entails a very extravagant use of timber, and is still more expensive to repair. Or, thirdly, we can remove the overhanging sides, and raise the new balk to the level of the roof. This makes the best of the three; but the removal of the sides is a costly work, besides possessing the additional disadvantage of again giving the middle roof full liberty to concentrate the load at the middle of the beam, and so recommence the whole difficulty. The only satisfactory course is that most seldom taken. It is to adopt the "herring-bone" method. By this method, and supposing the roof to have "arched itself," the main timber is not to be put in transversely, but longitudinally. A long balk of round timber (which need not be too heavy) is run longitudinally in the middle, where the roof is the highest, and temporarily supported on vertical props. Under the hanging sides places are dressed to receive side struts, whose other ends are carried to the longitudinal beam, which may, if thought necessary, be shaped to receive them firmly. The struts and balk being firmly wedged in position, the temporary props are removed. A length of timber thus arranged looks much like the interior view of a gabled roof, and is, in fact, sometimes called Gothic timbering. In the circumstances named, the economical value of this style of timbering can scarcely be over-estimated. The expense of taking down the overhanging sides is saved, these being securely timbered by the struts; and the sides thus left on have considerable influence in supporting the middle roof. The main timber supporting the heavy middle roof, being run longitudinally, receives a distributed, instead of a concentrated, load, and, further, being supported by numerous struts, has no long span, such as is necessary when the usual transverse method is employed. Shorter and cheaper timber may be used for the struts, and, finally, the strength of the whole arrangement is much greater, the renewals are much rarer, and the safety much more pronounced, than under the transverse system hitherto widely used, but altogether inferior.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*8194. The Iron and Steel Industry of Spain. Pablo de Alzola (Some information regarding the iron ore deposits and the importance of the workings, with consideration of the iron and steel industry). Col Guard–Sept. 4. 6300 w.

*8195. Modern Blast Furnaces and Production of Iron in Various Countries Translated from a continued article in *La Métallurgie* (The first part deals with the subject as related to the United States, Germany and Luxemburg). Col Guard–Sept. 4. 2200 w.

*8198. A Note on the Missing Carbon. T. W. Hogg (What the term "missing carbon" means, as used by H. M. Howe in a recent paper, with investigations showing that the carbon concerned is capable of exact measurement). Ir & Coal Trds Rev–Sept. 4. 1200 w.

*8199. The Roasting of Iron Ores, with the View to their Magnetic Concentration. H. Wedding (Extracts from paper discussing the influence of roasting on the reducibility of iron ores, and for subsequent magnetic treatment with other interesting matter). Ir & Coal Trds Rev–Sept. 4. 3300 w.

*8200. Sand on Pig-Iron and Its Avoidance. H. D. Hibbard (Describes apparatus for casting pig-iron, claiming a saving in cost and labor). Ir & Coal Trds Rev–Sept. 4. 2000 w.

†8213. The Magnetic Separation of Non-Magnetic Material. H. A. J. Wilkens and H. B. C. Nitze (The object of the paper is to set forth the substance of previous statements, made orally at the Atlanta and Pittsburg meetings of A. I. M. E., embodying therewith additional information gained since that time, and a brief illustrated description of the method and means of the separation). Trans Am Inst of Min Engs–Sept. 8400 w.

†8215. Laboratory-Tests in Connection with the Extraction of Gold from Ores by the Cyanide Process. H. Van F. Furman (Description of the latest laboratory methods. How to determine the adaptability of an ore to this method of treatment). Trans Am Inst of Min Engs–Sept. 5300 w.

†8217. The Concentration of Ores in the Butte District, Montana. Charles W. Goodale (A study of the treatment of these ores, which present a variety of combinations, with historical account of plants erected in the Butte district). Trans Am Inst of Min Engs–Sept. 16000 w.

†8221. The Bertrand-Thiel Open Hearth Process. Joseph Hartshorne (Describes a new development of the open hearth process which the inventors claim has increased the product per furnace, reduced the amount of refractories and additions used, enabled a poorer and more varied quality of stock to be employed, improved the quality of the material produced and rendered the control of the operations and product more certain). Trans Am Inst of Min Engs–Sept. 2000 w.

†8222. The Actual Accuracy of Chemical Analysis. F. P. Dewey (Compares the results obtained by several chemists, working upon the same sample and by various methods). Trans Am Inst of Min Engs–Sept. 3500 w.

†8223. The Occurrence and Behavior of Tellurium in Gold-Ores, More Particularly with Reference to the Potsdam Ores of the Black Hills, South Dakota. Frank Clemes Smith (Results obtained in the study of the refractory gold-ores of the Potsdam sandstone. Illustrations). Trans Am Inst of Min Engs–Sept. 6000 w.

†8225. The Microstructure of Steel and the Current Theories of Hardening. Albert Sauveur (Describes at some length the changes of microstructure which occur, during slow cooling, in steels containing various amounts of carbon, and examines what bearing, if any, such structural changes as occur at the critical points, have upon the current theories of hardening). Trans Am Inst of Min Engs–Sept. 14000 w.

†8226. Silver-Losses in Cupellation. L. D. Godshall (Treats of the losses sustained by silver, under certain specified conditions, during the process of cupellation, and the conditions which govern these losses). Trans Am Inst of Min Engs–Sept. 1400 w. and table of results.

†8227. The Cyanide-Process in the United States. George A. Packard (Data giving an idea of the development of the process and of the methods followed in the principal mills). Trans Am Inst of Min Engs–Sept. 3000 w.

†8229. A Modern Silver-Lead Smelting-Plant. L. S. Austin (Describes a plant whose site is assumed to possess natural advantages which are utilized to their full extent). Trans Am Inst of Min Engs–Sept. 5400 w.

8240. Aluminum. J. B. (Some of its characteristics). Can Eng-Sept. 900 w.

8248. Testing Metals for Hardness. A. Föppl, in *Contralblatt der Bauverwaltung.* (From *Iron and Coal Trades' Review.* A method of ascertaining the hardness). Am Mach-Sept. 17. 600 w.

*8312. Close-Sizing before Jigging. Robert H. Richards (Experiments undertaken by the author for the purpose of investigating to what extent equal sized particles, interstitial currents, acceleration and suction bear on the results). Eng, Lond-Sept. 11. 900 w.

8343. The Anaconda Electrolytic Copper Refinery (Illustrated description). Eng & Min Jour-Sept. 19. 4000 w.

*8344. A Note on the Presence of Fixed Nitrogen in Steel. F. W. Harbord and T. Twynam (Read at meeting of the Iron & Steel Inst. Investigations of authors, without conclusions being drawn). Ir & St Trds Jour-Sept. 12. 800 w.

*8345. The Present Position of the Iron Ore Industries of Biscay and Santander. William Gill (Part first relates to the province of Biscay and treats of the deposits, mines, working, transport and shipping, concentration and calcination). Ir & Coal Trds Rev-Sept. 11. Serial. 1st part. 3300 w.

*8346. The Estimation of Sulphur in Iron Ores. R. W. Atkinson and A. J. Atkinson (Description of method of analysis which gives very satisfactory results). Ir & Coal Trds Rev-Sept. 11. 1000 w.

*8347. The Le Chatelier-Heräus Thermo-Pyrometer. Dr. H. Wedding (Translated from *Stahl und Eisen.* Steps that led to its construction, and directions for use). Ir & Coal Trds Rev-Sept. 11. 800 w.

8408. Aluminum Bronze and its Uses in the Arts. From the *Aluminum World* (Defines term, gives discovery, valuable qualities, uses, strength, etc.). Foundry-Sept. 2300 w.

8441. The Manufacture of Wrought Iron. James Kerr (Paper read before the West of Scotland Iron & Steel Inst. Describes the conditions of the puddler and the puddling process as they were twenty-five years ago and as they are to-day). Ry Rev-Sept. 26. 1800 w.

8470. The Engelhardt Bromine Gold Extraction Process in Operation. D. C. Pret and H. Trachsler (Description of the successful treatment of tellurium ores at the bromination works of Pret, Trachsler & Co., at La Plata, Colo.). Eng & Min Jour-Sept. 26. 1400 w.

*8485. The Melbourne Mint (Description of the melting house, assay department, refining, and coining department). Aust Min Stand-Aug. 27. 3000 w.

8530. Improved Processes for Reducing and Saving Precious Metals. Alfred von der Ropp (Shows some of the new ways and means by which gold mining in the present is made profitable. Also calls attention to the superiority of American metallurgists and mining engineers). Min & Sci Pr-Sept. 26. 1900 w.

8532. The Cyanide Process at the Utica Mine. Thomas N. Smith (The process is limited to the slimes saved at the canvas plant. The work is explained, and a statement given showing results). Min & Sci Pr-Oct. 1. 700 w.

†8541. On the Estimation of Cadmium as the Oxide. Philip E. Browning and Louis C. Jones (Contribution from the Kent Chemical Laboratory of Yale Univ. The work described shows that when the carbonate is filtered upon an asbestos felt previously ignited the dangers of reduction are obviated and the carbonate process is simplified. The results are tabulated). Am Jour of Sci-Oct. 700 w.

†8543. The Action of Ferric Chloride on Metallic Gold. Parker C. McIlhiney (Experiments the result of which help to account for the solubility of gold in mine waters and in other waters containing iron, acid and common salt). Am Jour of Sci-Oct. 600 w.

*8592. Serrages (Obstructions) in Blast Furnaces. E. Bernard (Translated from *Revue Universelle des Mines, etc.* Information relating to obstructions in the body of the furnace). Col Guard-Sept. 25. 1100 w.

8594. The Transmutation of Silver into Gold (Correspondence from Von Schulz & Low, and F. M. Endlich in relation to this subject and Dr. Emmen's alleged discovery of "argentaurum"). Eng & Min Jour-Oct. 3. 2300 w.

8596. The Reduction Plant for Pyritic Gold-Bearing Ores, at Gibbonsville, Idaho. Bernard MacDonald (A brief description of the mines is given, followed by description of plant which has proved a success). Eng & Min Jour-Oct. 3. 2000 w.

8597. The Preparation of Alumina from Bauxite. James Sutherland (Description of the processes used by the British Aluminum Co, at the Larne Harbor works in Ireland). Eng & Min Jour-Oct. 3. 2200 w.

*8610. An Auxiliary Assay Balance. Robert Law (Read before the Chemical Society. Description of a new form of balance, which has been designed to meet a want felt by the writer when weighing the cornets obtained when pursuing the ordinary routine of gold bullion assay). Ind & Ir-Sept. 25. 1200 w.

*8611. The Metallurgy of Gold. C. C. Longridge (Patents of 1896, with notes). Min Jour-Sept. 26. 1800 w.

8624 The Gates Canvas Plant. W. S. Hutchinson (Description of plant and methods used at the Kennedy mill, near Jackson, Amador Co., Cal. The Gates methods are said to be adapted to any mill tails when their value is contained in the form of fine, rich, heavy material which escapes other methods of concentration). Min & Sci Pr-Oct. 3. 1300 w.

8636.—$1.50. Tension Tests (Tabulated data for iron and steel obtained in laboratory of Mass. Inst. of Tech.) Tech Quar-June-Sept. 2500 w.

8645. Varying Costs of Open Hearth Steel (Extract from new work by H. H. Campbell. On open-hearth costs). Ir Tr Rev-Oct. 8. 1500 w.

Mining.

*8128. The Phosphate-Rock Deposits of Tennessee. Ill. Lucius P. Brown (Showing the extent, character and methods of phosphate mining in Tennessee). Eng Mag–Oct. 4500 w.

8191. The Great Mother Lode of California. Harold W. Fairbanks (Abstract of a lecture delivered before the San Francisco Gold Mining Exchange (Explains the meaning of the term mother lode, and describes its features). Eng & Min Jour–Sept. 12. 2500 w.

*8192 Atmospheric Influences on Magnetic Survey of Mines. H. W. Halbaum (Recounts a remarkab.e experience that can only be explained by the theory of atmospheric influence). Col Guard–Sept. 4. 4000 w.

*8197. The Manganese Ore Deposits of Northern Spain, with Notes on Some Other Sources of Supply. Jeremiah Head (Extract from a paper giving particulars of a journey made four years ago in Northern Spain. Tabulated cost of working at the Asturiana mine and results of analysis of the ores; with interesting information). Ir & Coal Trds Rev–Sept. 4. 1800 w.

†8214. The Smuggler Union Mines, Telluride, Colorado. J. A. Porter (Data relative to this property and the treatment of its ores is given). Trans Am Inst of Min Engs–Sept. 2500 w.

†8216. Electric Mining in the Rocky Mountain Region. Irving Hale (States advantages of electric power, describes systems, gives history, illustrates and describes machinery and gives list of electric-power plants for mines, mills and melters in this region). Trans Am Inst of Min Engs–Sept. 5800 w.

†8218. Additions to the Power-Plant of the Standard Consolidated Mining Company. Robert Gilmore Brown (Describes additions completed during the last year, interesting because of the engineering features involved and of the attainment of a high degree of flexibility with the two-wire, alternating system of electrical transmission). Trans Am Inst of Min Engs–Sept. 4500 w.

†8219. Sketch of a Portion of the Gunnison Gold Belt, Including the Vulcan and Mammoth Chimney Mines. Arthur Lakes (Describes the area extending from the Cebolla River on the west to the head of Taylor Park and the Sawatch range on the east). Trans Am Inst of Min Engs–Sept. 3000 w.

†8220. Further Notes on the Alabama and Georgia Gold-Fields. William M. Brewer (Investigations made during the winter and spring of 1896, lead to additional facts and opinions since paper presented in Oct., 1895). Trans Am Inst of Min Engs–Oct. 3500 w.

†8224. Note on a Shaft Fire and Its Lesson. Robert Gilman Brown (The fire described occurred in the shaft of the Standard mine at Bodie, Cal). Trans Am Inst of Min Engs–Sept. 1300 w.

†8228. Gold in the Guyanas. Henry G. Granger (Memories and impressions of a year spent in visiting its principal mining properties). Trans Am Inst of Min Engs–Sept. 4400 w.

*8250. The Leith Mine. H. L. Auchmuty (A description of a modern mine and coke works in the Connellsville region. The geological features of the tract worked, the system of mining employed, and the method of timbering, ventilating and drainage, together with a description of the surface improvements). Col Eng–Sept. 7600 w.

*8251. Cripple Creek. Arthur Lakes (The changes and improvements which have taken place within the past year. A description of the building of the new city and the continued remarkable development of the mining industry in the vicinity). Col Eng–Sept. 2600 w.

*8252. Pike's Peak. Arthur Lakes (Its geological formation and the reason why the ore veins are few and poor). Col Eng–Sept. 1800 w.

*8254. Zinc Mining. H. K. Landis (A description of the methods of mining and dressing zinc ores at Friedensville, Pa.; together with a history of their discovery and development, and an account of the early difficulties met with in treating the ores). Col Eng–Sept. 1500 w.

*8255. Mine Ventilation. J. T. Beard (A study of the equivalent orifice method as applied to the measurement of the yield of fans. A general review of the method and of the development of the equations upon which it is based, showing that they are founded on an error). Col Eng–Sept. 4500 w.

8308. Copper Mines of Michigan. Dr. Richard Moldenke (Extract from a paper read before the convention of German-American Engineers. The location of mines, method of working, and methods of concentration). Am Mfr & Ir Wld–Sept. 18. 1800 w.

†8352. Gold Deposits in Nicaragua (An account of the explored portion of Nicaragua, with information from Mr. Courtenay De Kalb and O. O. Hill and from official sources). Cons Repts–Sept. 3800 w.

8402. Trail Creek Mining District (Notes taken from the report recently made to the Provincial Bureau of Mines, by William A. Carlyle. The history, ore deposits, ores, and their treatment). Min & Sci Pr–Sept. 19. 2800 w.

*8415. The Phenomena of Colliery Explosions. Donald M. D. Stewart (A paper read at the meeting of the Federated Institution of Mining Engineers at Cardiff. Account of investigations of the disasters at the Camerton and Timsbury collieries—two explosions not complicated by the presence of fire-damp). Ind & Ir–Sept. 18. 2000 w.

*8463. Mining in New Zealand. A. J. Cadman (A statement by the minister of mines, of the important features of the past year's mining). Min Jour–Sept. 19. Serial. 1st part. 2800 w.

*8465. The Leicestershire Coalfield (Description of Ibstock colliery. Two plants are in operation, and the method of working, underground haulage, underground pumps, boilers, winding, screwing, etc., are described). Col Guard–Sept. 18. 2400 w.

*8467. The Transvaal Coal Deposits. Extract from the London *Times* (Particulars of the mineral resources of the Transvaal). Col Guard–Sept. 18. 1300 w.

*8468. Hoisting from Deep Shafts. Walter McDermott (Read before the Inst. of Mining and Metallurgy. An illustration of a system of winding known as the Whiting hoist). Col Guard–Sept. 18. 900 w.

†8486. Nevada Silver. Charles Howard Shinn (An interesting account of the discovery of silver in Nevada, the history of the great Comstock lode, the methods of reducing the ore, and facts connected with the industry). Pop Sci M–Oct. 8000 w.

8531. Gold Mining in California. Aug. J. Bowie (The benefits to the government from the gold mines of the country. Also interesting information on hydraulic mining, legitimate and speculative mining, speculative mines, mining as a business proposition, with an outline of the topography and geology of California, gold quartz veins, depth of mines, etc). Min & Sci Pr–Sept. 26. Serial. 1st part. 3300 w.

*8590. Turquoise Mining in Persia (Particulars respecting the celebrated turquoise mines near Nishapur, in Persia, from report of Consul-General Elias). Col Guard–Sept. 25. 700 w.

*8591. A Compound Winding Engine. W. Galloway (The substance of a paper read before the North of England Inst. of Min. & Mech. Engs. Describes an engine recently erected at Llanbradach colliery, near Cardiff). Col Guard–Sept. 25. 1800 w.

*8593. The Brancepeth Colliery Explosion (Interesting particulars of the accident). Col Guard–Sept. 25. 5000 w.

8595. The Report on the Twin Shaft Disaster (Extracts from report to Gov. Hastings, of Penna., by the mine inspectors appointed to investigate the disaster). Eng & Min Jour–Oct. 3. 1100 w.

*8598. Gold in Western Ontario (Editorial review of the diffusion of gold in this province, the amount of development work, value of deposits, &c.). Can Min Rev–Sept. 2500 w.

*8599. Silver Mining in Kootenay, B. C. (Editorial review of silver mining in British Columbia, with illustrations). Can Min Rev–Sept. 4800 w.

Miscellany.

*8193. Hanging Fire of Grisounite Cartridges. M. Sarrau (From a report to the French Firedamp Commission. Accidents resulting from slow or partial explosions. or from explosions after detonations were heard). Col Guard –Sept. 4. 1300 w.

*8206. The Mansfield, Indiana, Sandstone. T. C. Hopkins (Description, with account of tests and results. Its durability, etc). Stone–Sept. Serial. 1st part. 3000 w.

*8207. Thuringian Quarries. H. J. W. in *New York Post* (Describes a tour of inspection of the gray wacke and slate quarries under control of the ducal government). Stone–Sept. 1300 w.

*8253. A New Prospect. Arthur Lakes (A practical example of how it is examined and the hardships connected with it). Col Eng–Sept. 1500 w.

8341. Colorado, 1889-1896. T. A. Rickard (A retrospect of the years which have lapsed and a consideration of interesting features). Eng & Min Jour Sept. 19. 2600 w.

8342. The Colorado Meeting of the American Institute of Mining Engineers (The programme of the meeting, with brief abstracts of a number of papers presented). Eng & Min Jour–Sept. 19. 4000 w.

*8398. Machinery for the Coolgardie Gold Fields. Allison D. Smith (Stating the need of machinery and suggesting the list of goods most needed, with editorial urging England to supply the need). Machinery, Lond–Sept. 15. 2500 w.

*8400. Miners' Lamps and the New Method of Testing Them (Brief illustrated description of method recently used in Austria). Mach, Lond –Sept. 15. 700 w.

*8462. Round Ropes v. Flat Ropes. George W. Westgarth (From a paper read before the British Soc. of Mining Students. Gives an instance showing the superiority of round ropes). Eng, Lond–Sept. 18. 800 w.

*8464. On the Choice of an Oil Engine for Mining Purposes. C. C. Longridge (A few simple principles as a guide to the purchase). Min Jour–Sept. 19. 1000 w.

*8466. The Manufacture of American Coke in 1895 (Extract from report by Mr. Joseph D. Weeks. Production, extent of the industry, prices, etc). Col Guard–Sept. 18. 1700 w.

8469. Colorado Meeting of the American Institute of Mining Engineers (List of the 48 papers presented, with brief abstracts of some of them). Eng & Min Jour–Sept. 26. 5000 w.

8471. Railroad Absorption of Mineral Lands in California. A. H. Ricketts (Explains the situation by which the Southern Pacific Railroad Co. have gained possession of mineral lands in California). Eng & Min Jour–Sept. 26. 1000 w.

*8484. Transmission of Power by Compressed Air. John Garvas (Advocates compression by stages to lessen the difficulties and losses in the direct compression of air). Aust Min Stand –Aug. 27. 2000 w.

*8589. The Health Conditions of Coal Mining. James Barrowman (A paper read before the Min. Inst. of Scotland, and printed in the Transactions of the Federated Inst. of Min. Engs. Statistics proving that even after including deaths from accident, the mortality among coal miners is less than that of most manual occupations). Col Guard–Sept. 25. 2600 w.

*8600. The Economic Value of Coal Dust. W. Blakemore (A brief paper summarizing the uses to which coal dust may be applied and the extent to which it has already been used). Can Min Rev–Sept. 1500 w.

*8612. A Reign of Coal and Iron (Progress achieved in these industries during the reign of Queen Victoria). Ir & Coal Trds Rev–Sept. 25. Serial. 1st part. 3800 w.

*8613. Economic Aspects of the Coal Industry (The first part deals with the extent and duration of the English coal fields). Ir & Coal Trds Rev–Sept. 25. 1200 w.

MUNICIPAL ENGINEERING

The Gas Light and Coke Company, London.

THE PROGRESSIVE AGE (Sept. 1) contains an abstract from "Notes on London Gas Supply," by James McGilchrist, which shows the magnitude of the business conducted by the Gas Light and Coke Company of London. From this statement we gather that the capital of the company is $60 000,000, and the present value of its stock $150,000,000. The company supplies gas to the buildings occupying seventy square miles of territory. The business of the company is conducted in nine different district offices. There are a large number of testing-stations and twenty-three valve-houses, with nearly four thousand valves on district.

"Beckton and Bromley supply practically one-half of the gas required, and they are what are known as high-pressure works, gas being sent out at times from them under no less a pressure than 300-tenths. Many of the up-town stations have districts assigned to them which require more gas than the station's manufacturing capacity. They have, therefore, to rely upon the balance being sent to them by means of the high-pressure system of mains, which practically interlace the whole of the company's twenty-seven districts. In addition to this, each up-town station has to take in a supply of gas into separate holders allocated for the purpose, to supply their proportion of the districts assigned to Beckton. Further, each up-town station has to take in a supply of gas from the high-pressure system sufficient to enable them (by means of their reversing pumps) to pump gas back into the high-pressure mains during the hours of heavy draught, to cushion up the pressure which is needed to supply the various district valve-houses with the necessary initial pressure. The pumping mains act in the double capacity of gas-holder supply-mains and district valve-house supply-mains. All the works, stations, etc., are connected by telegraph with Goswell road, and everything there is so arranged that the chief has only, as it were, to pull the string, and the figure moves.

"Gas manufactured at Beckton has to travel in a direct line seventeen miles, and experiment has proved that, if no other station were pumping into these mains during the time the heavy draught is on, 300-tenths pressure at Beckton would be reduced by consumption and friction to about 10-tenths at the extreme end, Fulham. There are also a number of districts which are known as transfer districts, and which, by means of valves *in situ*, can be supplied from different stations as may be desired, having regard to the stocks of gas available at the particular station. There are also a number of pressure stations all over the districts, situated at spots where pressures are known to be lowest, and the pressure-register sheets are forwarded each day to the central office as a guide for the future working of such pressure."

There are many widely different levels, and many districts are separately valved off to insure to each station its quota of distribution.

Particular attention has to be paid to the city (proper) of London. The city abounds in vaults and cellars (some of them seventy-five feet below the pavement level), in addition to the numerous underground railway stations and signals, all of which are lighted with gas, and Mr. Gilchrist says that "chess-playing is simply not in it with this—the London gas supply—as regards concentration of mind."

The company has two thousand miles of main pipes laid, ranging from forty-eight inches in diameter downwards. It supplies fifty-five thousand public lamps. Such of these as are not supplied to vestries and parishes under the average meter system are lighted and extinguished at the average rate of 1,500 per minute.

The company employs an army of over ten thousand men. It supplies a quarter of a million consumers. It has hired and sold 114,000 gas-stoves. Its gas-holders have a capacity for 115,000,000 cubic feet of gas, or about ninety per cent. of a heavy day's output. The heaviest day's output yet made is stated to be 128,000,000 cubic feet, for which, in round numbers, twelve thousand tons of coal had to be carbonized. Notwithstanding the magnitude and difficult conditions of the service, the loss by leakage is only a fraction more than five per cent. Some large places of amusement require 12-inch service pipes.

The Leicester Sewage Farm.

A LONDON correspondent has sent us a summary of a statement made by Mr. E. G. Mawbey, the borough surveyor of Leicester, England, which was put forth in a discussion of a paper on the present status of sewage irrigation in Europe and America, presented at the recent Sanitary Institute Congress, at Newcastle-on-Tyne.

The conditions at Leicester were considered very unfavorable to a sewage-irrigation system, yet very creditable success has been attained in the face of all the difficulties, arising chiefly from unsuitability of the soil. Mr. Mawbey, having carried out all the preparation of the land, particularly a new system of sub-drainage, explained the arrangements whereby, on clay land, the successful purification of the dense sewage of Leicester (population, 200,000) had been successfully accomplished.

The system was put in operation six years ago, and the land has been sewaged for six years. This is certainly long enough to demonstrate the success or failure of the system, and its success seems now entirely assured.

One of the most important factors of the success is that, whereas the foul affluent which always gets into the drains of clay land generally runs into the water-courses and rivers, the foul effluents in this scheme are run out on to the surface of lower land again and again, and a high condition of purification is effected and maintained, notwithstanding that the summer flow of water in the river is often less than the volume of sewage treated.

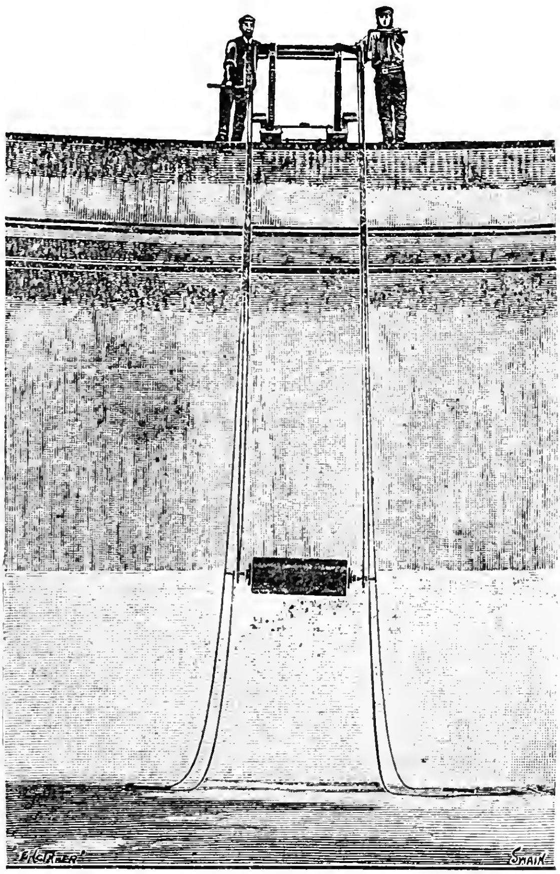
With reference to the above statement, Mr. Rogers Field said, in substance, that he regarded the successful experiment at Leicester as demonstrating the fallacy of an opinion hitherto entertained that successful sewage irrigation can be carried out only where land of a suitable description is obtainable. It often happens that land hitherto considered suitable can be had only at an exorbitant price, while unsuitable land can be had in laige quantity and at a low figure. The demonstration of the possibility of effective sewage purification on unsuitable land is, therefore, of national concern. What has been done at Leicester is greatly in advance of anything in this direction hitherto accomplished, and the problem is solved by the re-application of the effluent from the land drains.

The *Leicester Daily Post*, commenting upon Mr. Mawbey's statement, and upon the system which he has evolved, says:

"Even when the soil is in every respect adapted for the purpose, the process of sewage purification and utilization is by no means as easy as many imagine. When, however, as at Beaumont Leys, the engineer is confronted by a stiff clay, a vast volume of sewage, and the most sluggish water-flow in all England, he may well despair. Happily, Mr. Mawbey has not only proved fully equal to the emergency, but has solved the problem in a fashion which the gratifying experience of the past six years has demonstrated to be a complete success. We can still remember the confident predictions of hopeless and extravagantly expensive failure amid which the experiment was launched, and which have long since been so pleasantly falsified. Nor have we far to seek for the open secret of success. It is to be found in the tact with which Mr. Mawbey has contrived to make abundance in quantity neutralize and compensate for lack of quality. That the measures which have been taken have proved a gratifying success is shown by many facts. One is the character of the effluent, which has disarmed the hostility of even the rivers pollution committee of the county council. Another, and by no means least significant, is the abandonment of all purification by chemicals."

Device for Cleaning Sides of Open Reservoirs.

THE sides of open reservoirs often get foul with vegetable growth, amongst which much minute animal growth finds a habitat. When such accumulations are to be removed, as may happen according to the rapidity with which the walls become loaded, wire brushes, scaffolding, and other paraphernalia are, in the ordinary way, required for the operation, and a deal of hard labor is expended. The device herewith illustrated is designed to facilitate and lessen the labor now required for cleaning reservoir walls. According to *The Engineer* (Sept. 11), from which the engravings are reproduced, the machine was designed by Mr. J. F. Rodda, superintendent of the Eastbourne (Eng.) waterworks.



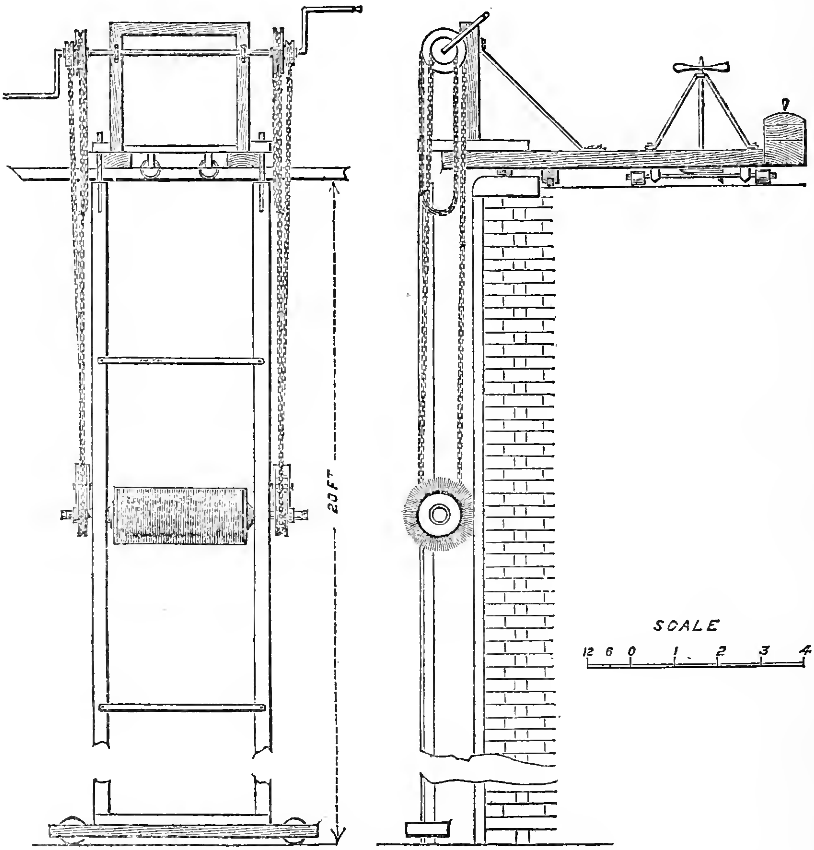
RODDA'S RESERVOIR WALL CLEANER

The engravings are so self-explanatory that a very brief description suffices. "The wood frame is fixed on low wheels to facilitate its being worked around the coping of the reservoir wall easily by means of a pair of bevel wheels. The revolving broom is hung in differential pulley block chains carried over the usual sprocket wheels, and running up and down in light angle iron guides hung on the wood frame, when used in cleaning vertical sides of reservoirs. If the sides of the reservoir are sloping, the guides are not necessary, as shown by the above view from a photograph herewith. A flexible hose is attached to the wood frame, joined to a sprinkler which conveys a stream of water down the side of the wall being scrubbed."

The Metering of Water.

WHILE admitting that there is an enormous waste of water in cities which would be checked by metering, the universal application of meters was objected to by Mr. R. E. W. Berrington, in a paper read by him before the British Association of Water-Works Engineers. An abstract of the paper (*Journal of Gas Lighting*, Sept. 1) sets forth his reasons for this objection. The waste of water in the United Kingdom, declares the author, is so enormous that, were a monetary value placed upon it, it would be viewed as a national calamity; yet he thinks meters used as a check to this waste would so stint the use of water among those who need it most that the effect would be insanitary. To save a little money those who get money by the hardest toil and those in penury would use as little water as possible, and thus their already insanitary condition would be intensified. Much of the waste of water in cities is not due to wantonness, and may be checked without resort to meters. Yet, as this is largely underground waste, it adds its insanitary effect to existing evils. Sodden ground underneath, and in the near vicinity of crowded tenements, is a source of great danger to the occupants. Subsidence of service pipes, defective joints, defective ball-taps, unduly large flushes for water-closets, taps subject to frost in open courts, etc., are named as important sources of waste.

The waste meter system and house-to-house inspection have been found effective in restricting waste. An instance of a reduction of consumption of three gallons per head resulting from a single inspection is cited. "In new works it is easy to arrange for the waste-meter system; and it is desirable to make such provision. The insertion of a stop-tap on each service should be looked upon as a *sine quâ non.* The water engineer manages his works as well for a company as for a corporation; but the author supposes there will be a consensus of opinion that the supply of such an essential as pure water should be in the hands of the local authority. It is a question as to whether the water and sanitary arrangements of the household should be under the immediate control and actually maintained by the local authority,—first, on the score of public health, and, next, in order to secure efficiency and economy in those works in which the general community has a direct interest. The competition among plumbers, and the desire of householders to get the work done cheaply, lead to the use of



RODDA'S VERTICAL RESERVOIR WALL CLEANER

much inferior material and bad workmanship; and this often means disease and deteriorated health, if not death."

It is suggested that in every water-works a system of stamping fittings should be in operation, and samples of approved fittings should be exhibited; that mains should be laid with not less than 2 ft. 6 in. or 3 ft. cover, and that they should be tested before being covered up; that reliable self-closing taps may be introduced with advantage in many cases, and without the concussion that used to be experienced with the old type of tap; that economy in water will often effect a saving in capital expenditure, annual working expenses, and wear and tear of machinery. The following table shows the quantity of water which escapes through small apertures, the figures being from actual tests:

Description of Fitting under Test.	Gallons Wasted in 24 Hours.
½-inch bib-tap, washer bad.......	700
⅜-inch tap, washer bad......	920
¾-inch tap, screw stripped........	12,720
⅜-inch ball-tap, washer bad.......	900
⅜-inch ball-tap, lever strained.....	200
Pipes burst by frost, ⅜ inch.......	11,280
" " " ½ inch.......	17,280
Taps left open, ¾ inch	23.520
" " ½ inch...	12,000
" " ⅜ inch............	9.600

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

8160. Inclined Retorts at Cassel, Germany. Emil Merz (Abstract from a paper read at the German Assn. of Gas and Water Engs. A general description of the system and statement of its results, which have proved good). Am Gas Lgt Jour–Sept. 14. 1400 w.

*8176. Gas Lighting by Incandescence (A general illustrated review of progress in the art of incandescent gas-lighting, compiled from the most authoritative sources). Engng–Sept. 4. Serial. 1st part. 1400 w.

*8246. The Decomposition of Hexane by Heat. F. Haber and H. Samoylowicz (Main features of some recent German experiments). Gas Wld–Sept. 5. 1200 w.

8372. The Coming Light. From *L'Illustration* (Illustrated description of the Denayrouse lamp). Sci Am Sup–Sept. 26. 1600 w.

*8449. The Self-Enrichment of Coal Gas. R. G. Shadbolt (Read at Eastern Counties' Gas Managers Assn., Retford. An exceedingly interesting account of a series of persistent experiments resulting in the development of a new method for which a patent has been secured. The method is simple and requires no labor expenditure after the apparatus (illustrated) has been installed. An average enrichment of two candles is claimed as the result. Discussion postponed till ensuing meeting). Gas Wld–Sept. 19. 4500 w.

*8450. Observations on the Construction and Working of Regenerator Settings. W. J. Jenkins (Read at the Eastern Counties Gas Managers Assn., Retford. The aim of the paper is to point out divergencies from a reasonable theory as found in many types of construction and to evoke discussion on the opinions advanced). Gas Wld–Sept. 19. 4200 w.

†8487. Acetylene the New Illuminant. V. J. Youmans (General review of progress in the manufacture and use of acetylene as an illuminant). Pop Sci M–Oct. 3000 w.

Sewerage.

8136. The Sewerage and Sewage Disposal Systems of Plainfield, N. J. Andrew J. Gavett (Illustrated detailed description. Irrigation system. Contract prices for different parts of the work). Eng News–Sept. 10. 7000 w.

*8243. Chemical Sanitation and Public Health. William Brown (Illustrated description of low level drainage system at Sutton in Surrey, Eng., and remarks upon antiseptic sanitation in connection with this kind of drainage). San Rec–Sept. 4. 2000 w.

*8317. Jointing of Sewers and Drain Pipes. R. S. Rounthwaite (General defectiveness of this class of work. Methods employed are described and criticised). Ind & Ir–Sept. 11. 2200 w.

*8318. Sewerage and Sewage Disposal of Colliery Villages. John Edward Parker (Read at the congress of the Sanitary Inst. Newcastle-on Tyne. Insanitary condition of many colliery villages. What has already been done, and what remains yet to be done for their improvement). Ind & Ir–Sept. 11. Serial. 1st part. 800 w.

*8568. Manchester Sewage Disposal (Description of important extensions of the sewerage system of Manchester, by a scheme of effluent disposal, and a further scheme of sludge disposal, in addition to the original scheme of main drainage now being carried out). Eng, Lond–Sept. 25. 4500 w.

Streets and Pavements.

*8126. Pavement Construction and City Growth. Stevenson Towle (Discussing the various types of pavement in their relations to health, wealth and comfort). Eng Mag–Oct. 4900 w.

†8233. Street Cleaning (From the *Brooklyn*

Eagle, commenting upon the section on street cleaning in the proposed charter for Greater New York). San-Sept. 2800 w.

*8544. Granite Paving in Berlin. Robert Grimshaw (Illustrated description, as per instructions of the city inspector). Munic Engng-Oct. 2000 w.

*8546. Cost of Single-Course Brick Street Pavement. T. S. McClanahan (Abstract from paper read before the Ill. Soc. of Engs. The method of laying 4,878 square yards of brick paving, inclusive of preparation, and the detailed cost of the entire work is given. The pavement is shown to have cost $1.43 per square yard). Munic Engng-Oct. 400 w.

*8548. Experiments on Vitrified Paving Brick. F. F. Harrington (The testing laboratory of the St. Louis water, sewer and street commissioners is the place where the experiments described were conducted. Results of uniform tests of a variety of paving bricks are presented, with three plates of diagrams). Jour Assn of Engng Soc-Aug. 3000 w.

8609. Brick Pavements (Read before the Massachusetts Highway Assn., by James A. Davis. A general review of the progress and present status of brick paving, from which the author concludes that pavements of good brick, properly laid in the manner he describes, are superior in all respects to any other known kind of pavements). Brick-Oct. 2000 w.

Water Supply

*8129. The Water-Supply of a Tropical City. Ill. Raimundo Cabrera (Describing the construction of the famous Canal de Vento at Havana). Eng Mag-Oct. 3800 w.

8174. The Southbridge, Mass., Dam (Brief illustrated description of dam for the new water supply). Eng Rec-Sept. 12. 500 w.

8175. Omaha, Neb., City Water Works. Owen T. Smith (Development, general design and construction, pumps, pipe line, settling, aeration, general plan and section of basins and arrangement of pipes at pump-house). Eng Rec-Sept. 12. Serial. 1st part. 1600 w.

†8232. Purification of Water by Metallic Iron. C. W. Chancellor (Description of the process as carried out at Antwerp and other European cities). San-Sept. 2400 w.

8282. Scranton, Pa., Water Supply (Illustrated description). Fire & Water-Sept. 19. 800 w.

*8292. Mechanical Filtration (Editorial discussion of mechanical filtration as carried out in the United States). Engng-Sept. 11. 1500 w.

*8313. Revolving Broom for Cleaning Sides of Open Reservoirs (Illustrated description). Eng, Lond-Sept. 11. 200 w.

8523. Filtration of the Philadelphia Water Supply (Review of the movement in Philadelphia for better water and of the report of Mr. Allen Hazen upon a system of filtration of the supply). Eng News-Oct. 1. 1100 w.

*8545. The Financial Management of Water-Works. Freeman C. Coffin (Abstract from paper read before the New England Water-Works Assn. Pertains wholly to municipal water works, and deals with several important questions relating thereto). Munic Engng-Oct. 3400 w.

8550. Thirty Million Gallon Hammond Water-Works Engine at Buffalo, New York (Illustrated description). Power-Oct. 700 w.

8561. A Special Street Fire Hydrant (Illustrated description of a special form of hydrant developed in Providence, R. I., where the water pressure in the business districts is delivered at a pressure of 105 lbs. per square inch). Eng Rec-Oct. 3. 700 w.

8581. Newark's Water Supply (Illustrated description of waterworks at Newark, N. J. Fire & Water-Oct. 3. 1200 w.

Miscellany.

*8161. The Importance of Sanitary Inspection. Andrew Young (Extracts from report of the chief inspector of the Chicago Health Dept. The welfare of the common man, not alone those who can afford to live in luxury, should be the aim of all health boards). Pl & Dec-Sept. 1200 w.

†8201. The Henry-Campion Destructive Incinerator (Illustrated description of a destructor furnace invented by G. Henry and J. M. Campion, Executive Engineers of Umballa, India). Ind Engng-Aug. 8. 1300 w.

†8230. Public Baths Essential to Public Health. Moreau Morris (Read at a public meeting held in the Aldermanic Chamber, City Hall, New York. A strong plea for establishment and maintenance of public baths). San-Sept. 1500 w.

†8234. Suburban Sanitation. G. B. Thornton (Read at meeting of Tennessee Medical Soc., at Chattanooga. Need for better suburban sanitation and plans discussed. Reprinted from *Commercial Appeal, Memphis*). San-Sept. 2500 w.

8327. The Buffalo Free Bath-House (Illustrated detailed description). Eng Rec-Sept. 19. 3000 w.

*8376. The Government of Greater New York. Francis V. Greene (Presents the difficulties and needs, the existing conditions, etc., with reference to city government in various parts of this country and in foreign lands. Contains interesting information). Scribner's Mag-Oct. 7000 w.

8533. Electricity in Cleaning City Streets (Illustrated description of the latest development in the art of street cleaning. A self-loading car removes the surface accumulations and is driven by electricity taken from the trolley wires). W Elec-Oct. 3. 600 w.

8582. The Fire Departments of Europe in Comparison with American. Chief Hosmer (Read at convention of the Mass. Fire Assn., at Brocton, Mass. A very interesting comparison based upon personal observation and study). Fire & Water-Oct. 3. 4600 w.

8627. Garbage Utilization at Cincinnati and New Orleans (Illustrated description of apparatus, and the Simonin process of treating garbage, as carried out in the cities named). Eng News-Oct. 8. 5000 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Some Interesting Points in Rapid Transit.

IN the *Railroad Gazette* (Sept. 11) there appeared a striking and admirable analysis of typical urban passenger-travel, prepared by Mr. Theo. Cooper and based upon the station-to-station traffic of the New York Manhattan (elevated) system. The most notable conclusion drawn by Mr. Cooper from the table was "that express travel on a rapid transit road will not pay."

In the Sept. 25 issue of the same excellent journal Mr. Wm. Barclay Parsons, the engineer of the New York rapid transit commission, ably reviews Mr. Cooper's arguments, but supports very different conclusions. It is noteworthy at the outset that the broadening effect of a thorough engineering training is manifested in the toleration extended by both debaters to the views of opponents, and the readiness to grant that incomplete data, especially, may be combined to accord with more than one hypothesis.

The data in this case are admittedly insufficient, and, pending their completion, Mr. Parsons says:

"In the study of the rapid-transit problem, an interesting feature has been the great divergence of opinion on this subject, the opinions varying all the way from the extreme on one hand, as represented by Mr. Cooper, to the extreme on the other of maintaining that only the fast traffic will pay, and that, if a road were built for express service alone, the greatest returns would be obtained on the investment. Of course, until the experiment is tried, all statements in this regard are largely matters of personal opinion, and the writer is of the belief that the best results will lie somewhere between the two extremes, and be reached by a proper combination of local and express service."

The first point of general importance which he brings out is that an apparently trivial saving in time is apparently regarded by the average passenger as highly valuable. This is in line with Col. Prout's conclusions in his article in this number of THE ENGINEERING MAGAZINE. Suburban travel is there shown to be the class most largely increased by an increase of train-speeds; the same principle would naturally apply with still greater force to the shorter distances of urban traffic.

Mr. Parsons's conclusions are derived from a study of the conditions as they manifest themselves in New York; but they are so indicative that a citation of one of his instances, at least, will be of wide value and interest.

"The Third avenue road during the busy hours in the afternoon runs each alternate train from City Hall as an express train. Inasmuch as these express trains are sandwiched between locals, the only benefit that can be derived from them is where they reach section trains of third track,—namely, north of Fifty-ninth street,—and the greatest number of local trains that they can pass there is three, while frequently they do not pass more than two; yet passengers will leave the preceding local trains at Fifty-ninth street in order to take the express trains, although they know that these express trains are so crowded that a seat is an impossibility, and that the gain will not be more than one or two trains. On the west side the express trains do not stop after leaving Franklin street until reaching One Hundred and Sixteenth street, and yet passengers in large numbers on every express train will go to One Hundred and Sixteenth street, which has an island platform, and then wait for a southbound local and go back, some as far as Eighty-first street, a distance of 1¾ miles or a total extra journey of 3½ miles, as by thus going beyond their destination they can save about three minutes.

"It is the knowledge of these things that leads those who differ with Mr. Cooper in the other extreme to claim that the express-train service will be the most used, and, therefore, the most profitable. If people will resort to these expedients for the small saving in time that has been mentioned, is it unreasonable to suppose that, where every facility is offered for a transfer,—namely, merely stepping across an island platform,—passengers will avail themselves of it?"

The second, and perhaps still more widely important, point which Mr. Parsons brings out, collaterally to his main argument, is the extraordinary effect of reduction of fares in increasing volume of traffic and net revenue to the transportation companies. The Manhattan system is again the typical example:

"In the fiscal year 1887 the Manhattan system introduced a five-cent fare through the whole twenty-four hours, previous to which time it had been charging five cents during certain hours of the day and night and ten cents during the remainder of the day. Previous to that its annual increase in travel had been from six to ten million passengers, and yet its increase during 1887 amounted to 44,600,000 fares as against a total business for the preceding year of 115,200,000, or a sudden increase of over 38 per cent. Of course, the natural conclusion would be that such suddenly abnormal increase without the addition of any new lines would mean that the business was taken entirely, or almost entirely, from the surface-roads. As a matter of fact, the surface-roads showed a loss of only 8,000,000 passengers, and the total traffic gain for the city was 36,500,000, as against a normal increase of from 15,000,000 to 16,000,000 during the previous years. That is to say, the giving to the public of a fast service at no greater cost except the personal inconvenience of climbing the stairs more than doubled the normal annual increase. It is interesting to note that this reduction in fare caused an increase not only in gross receipts of the Manhattan Company, but actually in the net receipts after paying operating expenses, and that the reduction of the fare was a source of increased revenue to the company."

This experience is earnestly commended to the attention of some of our contemporaries who can see nothing in proposed fare-reductions except a directly proportionate reduction of total revenue to the road, to be met (according to their conceptions) only by a corresponding cut in employees' wages.

Theorizing from imperfect data is very uncertain. The test of experiment does not seem to have established "the fallacy of cheap car-fares."

The Widening Approval of the Tie-Plate.

THE general attitude of maintenance-of-way men toward the tie-plate, as defined by the reports of the committee on roadway of the American Society of Railroad Superintendents and the committee on tie-plates of the Roadmasters' Association of America, shows a very strong agreement as to essentials, and a rather remarkable disagreement as to details.

There seems to be complete accord as to the "qualities necessary in a tie-plate to fulfil the service it is called upon to perform," which, following the abstracted reports in *Engineering News*, are defined by the superintendents' committee:

"1. Adhesion to the tie, so that it can be considered as practically a part of it, preventing damage to the wood-fiber, and rattling by passing trains.

"2. Adhesion to the tie to prevent its lateral movement, even on curves of high degree, so that the track cannot spread.

"3. The above vertical and horizontal adhesion to be obtained by such a mode that it will not assist decay of the tie.

"4. It should be so constructed that its application be simple and economical.

"5. Its cost should be sufficiently low so that, when added to the total cost of the tie in place, it will, by sufficiently prolonging the life of the tie, pay for itself, due allowance being made for a saving in labor on track-repairs, and a better condition of track.

"The fulfilment of these requirements should have the following results:

"1. Prevent damage to the tie by the rail cutting into it;

"2. Make the use of rail-braces unnecessary;

"3. Make possible the use of soft wood and longer-lived ties on curves as well as on tangents, and on all conditions of track;

"4. Make possible the use of a tie in the track during its natural life under the most trying conditions of alignment, grade, and traffic;

"5. Greatly reduce the expense of maintenance of track to proper line and surface;

"6. Make possible the maintenance of track in a safer condition, and afford relief to our forests of tie-producing timber."

That these results are in large measure secured in all cases is at once apparent on reading the correspondence submitted with the report. Forty-nine roads out of seventy-three responding to the superintendents' committee's inquiries had had more or less experience; the reported increase in the life of the tie varies from thirty per cent. to one hundred and fifty per cent., the difference being most noticeable on curves and under trying conditions of alignment and traffic. As to the other points, the selection is concisely summed up by the roadmasters' committee thus:

"On the second division of the subject-matter: 'Will the Use of Tie-Plates Dispense with the Use of Rail-Braces?' your committee, after a most thorough and searching experiment and investigation, unhesitatingly state they will do so. We have received reports showing where they have proved successful on curves of 3° 30′, 4° 25′, 15°, and even on 60°, where they have held the rail in place without any rail-braces being used. Moreover, no lateral movement or cutting of ties has occurred on these curves, and the track is in perfect and true gage. Your committee has had reports from chief engineers and roadmasters in all sections of this country, where ties have been used under almost all possible conditions with and without tie-plates, and the reports received show that the use of the tie-plate is a very necessary appliance on all track-work.

"Its use is economic, as it reduces the repairs on the road-bed, and makes a more perfect track, with consequent reduction on repairs of rolling stock. Further, its use as a measure of safety is beyond question, for it means truer gage to the track. Your committee unite in recommending the general use on all repair and construction work of the tie-plate, and feel that its added cost to the track maintenance will be more than compensated by the cost of labor saved in tie renewals alone."

But, passing from results to types, harmony gives way to confusion. Wide plates and narrow plates, thick plates and thin plates, flat plates and shouldered plates,—all have their advocates.

"It is observed that, where a very positive preference is expressed for a particular kind of plate, it is often the case that no experience has been had with any other form, which is a good argument for tie-plates in general, but not a strong one for the superiority of one form of plate over the other. There are some notable exceptions, however, where, after having made extensive experiments with several kinds of plates, one particular form has been finally adopted. These cases are deserving of the most serious consideration."

The greatest diversity of opinion is upon the question "whether the union of the plate with the tie shall be secured by ribs entering the tie parallel with the grain, or by lugs or claws entering the tie at right angles to the grain. Of the forty-four opinions received on this point, twenty-eight declare their unqualified preference for the plate with longitudinal ribs, eight are equally as positive in their preference for the other form, three appear to be as well satisfied with one as the other, and five have not yet formed a positive opinion either way."

The majority is large in favor of the longitudinal rib; it is amusing to notice that, while some oppose the form, as tending to split the ties, others advocate it, because, "when the tie begins to decay, the longitudinal flanges hold the soft fibers of the wood together, thus prolonging the usefulness of the tie."

Probably each form has its special merits for certain situations or certain kinds of wood, and only much wider experience can settle upon standards adjusted to varying conditions of practice.

The Profession of Railroading.

COL. H. G. PROUT, in addressing the Western Railway Club in response to the toast, "The Press," at Chicago, Sept. 15, summed up so admirably the proper relation of railroad men to their work that we can do no better than give that portion of his address *verbatim*. Col. Prout said:

"I have spoken of the railroad profession. Perhaps this is premature. Perhaps I should have said railroad business, or occupation, or calling. Perhaps railroading is not yet a profession. The Century dictionary defines a profession as 'a vocation in which knowledge is used by its practical application to the affairs of others in serving their interests or welfare.' Worcester has defined it as 'an employment requiring a learned education.' Obviously, railroading does not yet fill this definition. No one has yet organized a course of study by which one shall become possessed of the fundamentals of railroading as a learned education. There is an effort now on foot to establish such a course in one of the great universities, but the president and some of the faculty of that university, and many old railroad officers, have doubts if this calling can be organized into a profession to be prepared for by systematic courses of study in college. It seems to them too big and complex. It seems to be too much affected by the ever-changing conditions of human life to permit it to be taught as a science with fixed laws. The art of its administration, like the art of government, cannot be imparted by teachers to pupils as can the principles of the law and the gathered wisdom of the pathologist.

"Many other professions contribute to the administration of the railroad, but the engineer, the architect, the lawyer, the doctor, even when they give their lives to the service of the railroad, still remain professional engineers, architects, lawyers, and doctors. But this is not the whole story.

"A profession is more than a calling for which one is prepared by learned education. When we say profession, there at once arises in our minds the thought of an unwritten, unformulated body of tradition which governs conduct. There at once comes up a notion of a special standard by which we measure performance. We remember that we ask first and always of a professional man that he should do the work which he undertakes for someone else just as well as he possibly can, regardless of its effect on his own fortunes. We remember that a professional man may be highly successful, and yet make no money for himself. When we think of a man who has attained real eminence in his profession, the last thing that we think of is his private fortune or his public office. A profession, then, is a calling around which have grown up certain traditions of self-sacrifice, for which mankind has set up certain very exacting standards which demand in its followers, above all other things, devotion to duty. Thus we get at a simple expression of the bottom principle of the profession which distinguishes it from other callings or occupations. The professional man assumes an obligation towards his client; until he gives up that obligation, his duty to his client takes rank before his duty to himself. All this we may sum up in the term 'professional spirit.'

"Now, I come to the bearing on you and me of this attempt to state what we mean by a profession. I like to think that the professional spirit is growing fast among railroad officers. Whether or not railroading is a profession; whether or not it ever can be a profession,—is a small matter; and the vital thing is that railroad officers should have the professional spirit. We must look to this spirit to save the railroads from the ignorant and corrupt subordinate. We must look to it to save the railroads from the brigands in high places seeking only to make their own fortunes. Perhaps we must look to it to save the railroads from confiscation by Socialists and Populists, and, in fact, by honest voters who would come to be classed with either. How the professional spirit will do all this I need not point out. It will administer the properties for the interest of their owners, and not for the profit of salaried officers. But, in the long run, the interest of the owners is the interest of the public, and thus we find the probable solution of much that is most troublesome in what is called the railroad problem."

Col. Prout makes a particularly impressive point when he refers to railroading as being "too much affected by the ever-changing conditions of human life to permit it to be taught as a science with fixed laws." In no other branch of modern development, perhaps, have the standards of yesterday been so little applicable to the work of to morrow.

The situation is like that of Alice in Wonderland, when she ran furiously until exhausted and breathless, only to find that she had merely kept abreast of the country, which, when she stopped, rushed swiftly past her. The marvelous expansion of the past quarter-century has kept the railroad only abreast of the times; the wonder is, not that so few roads have passed the ordeal with financial success, but that so many have met the ceaseless demand for more money, broader measures, and abler men.

There seems to be a pause now, but the impression may arise merely from the human tendency to cling to the fixity of the present. He would be an unwise prophet who should predict more than that, whatever the development, the railroads will be equal to the demands.

State and Corporate Railway Ownership.

THE advocates of State ownership of franchises generally, and of railways in particular, might find interest, if no great satisfaction, in studying the results of experience in India. The construction and operation of railways there, according to *The Indian and Eastern Engineer*, has been governed by a policy which "has constantly changed, and will, no doubt, change in the future with circumstances which are constantly altering"; but it has always involved a larger or smaller measure (and generally a larger one) of State management.

A writer in *The Economist* says: "It was the intention of the statesmen who were responsible for the first beginning of railways (in India) that, as far as possible, these should be free from the evils which have marked the growth of railways in other countries." They determined that at least the main arteries should not be laid down haphazard, but that each project should be rigorously scrutinized in the light of its purpose as a part of a preconceived and symmetrical network, intended to serve the great centers of trade and, at the same time, strengthen the military and political position of the State.

"The agency then selected for the construction and working of these lines was that of guaranteed companies, who, in return for support, were subjected to rigorous control of their operations in every detail. This policy lasted for twenty years.

"But in 1869 a new departure took place. It was then decided to abandon the system of guarantee, as, indeed, of private enterprise in any shape, and to construct and work new lines by the direct agency of the State," "and so, it was supposed, save," comments the *Indian and Eastern Engineer*, "the enormous profits made by contractors under companies."

"For reasons which need not be here detailed, the policy of guarantee was again renewed in 1880 'in a modified form.'" "From this time we can follow the development of an instability of policy continuing to the present time," with results illustrated by the fact that there are now:

"(1) State lines made and worked by the State;
"(2) State lines made and worked by companies;
"(3) Lines made and worked by guaranteed companies;
"(4) Lines made and worked by assisted companies;
"(5) Lines made and worked by native States;
"(6) Lines made and worked (?) by native States and worked by companies."

"No parallel to this medley of conditions may be found in other countries, yet it may be safely asserted that in India, if anywhere, the government had a perfectly free hand to determine which method should be adopted."

The vacillation and confusion are traced largely to inharmony and conflict of authority between the government of India and the home government; but the essence of the matter, so far as the results and tendencies of State ownership are concerned, is summed up in the following paragraphs;

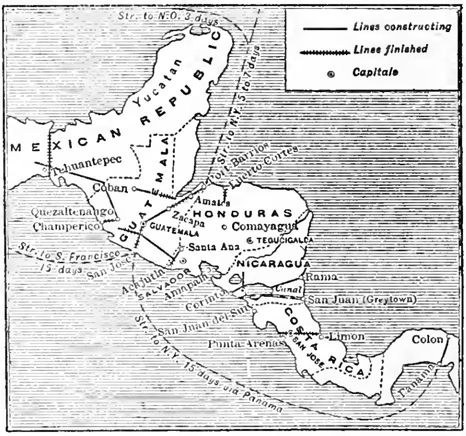
"The latest phase is to be seen in the tendency to relinquish the working of State lines by State agency, and to make them over to be worked by existing or new companies. Another equally important departure is in the re-arrangement and combination of the administrations of existing lines. The first of these is undoubtedly a move in the right direction, whatever may be the grounds for continuing the construction of railways by the State directly. There is now an almost complete agreement amongst the railway men in India that the working of railways by the State is less successful than by the agency of companies, notwithstanding that the former system has been tested by twenty years' experience, and although every endeavor has been made of late years to free the hands of the government officers. But the fault does not lie with them. It is to be found in the essential conditions of government administration, its inherent disposition towards centralization, its want of elasticity and of sympathy with the trader, its absence of initiative and of effective stimulus to its servants. The result is that the best men are drawn away by companies, by the attractions of better emoluments and better prospects, and it may be added that in no case have they failed to justify their selection.

"The position developed from the experience of the last few years seems to show that railway extension in India will not attain to the progress which the country now requires and desires, until the direct administration of railways by the State has ceased."

Railroad Development in Central America.

In connection with the map reproduced below, *The Iron Age* says:

"Four out of the five Central American States are actively pushing the construction of railroads through their territory, several new concessions or grants having been made lately. The British company who were to build the western section of the Costa Rica Interoceanic having failed to comply with the conditions of their contract, the government has declared same rescinded, and a new contract has just been signed with New York, California, and Colorado capitalists to finish



THE RAILROADS OF CENTRAL AMERICA.

the western terminus, thus connecting the two oceans and passing through San José, the capital. This company have a capital of $1,500,000, and work will commence at once."

Several other projects are mentioned, some transisthmian and some designed to link the several republics together and eventually form a portion of the great North and South American Railroad of the future; but the greater portion of the space is given to "Northern Interoceanic of Guatemala," progress upon which is thus described.

"Rails have been laid (from Puerto Barrios) to Zacapa, on the central plateau, the most difficult work having been completed when the line crossed the swampy district of Amates and Tenedores. Grading has been carried to within sixty miles of the capital, and, as the work is mostly in the hands of competent contractors, it is expected that through connection from the capital to the Atlantic will be had by the end of next year."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

Construction.

*8181. Current Railway Construction (Notes of work now under way in England). Engng-Sept. 4. 900 w.

8439. New Shops at Concord, N. H.,—B. & M. R. R. (Description of structures and arrangement, with sketch plan). Ry Rev-Sept. 26. 800 w.

8451. The Park Avenue Viaduct Improvement, New York City (Descriptive account of an extensive and important piece of construction, with drawings of many details). Eng Rec-Sept. 26. 900 w.

8493. Activity in Railroad Building in Central America (A brief statement of work completed and in progress, and of the improvement in communication which will result. Map). Ir Age-Oct. 1. 700 w.

Electric and Street Railways.

8144. Compressed Air Traction (A letter from Robert Hardie, objecting to an editorial published in this paper, with remarks from the editor). Elec Wld-Sept. 12. 1300 w.

*8153. The Glasgow District Subway (Description of construction and operation of an underground rapid transit cable road just to be opened). Arch, Lond-Sept. 4. 1400 w.

*8156. A Combined Conduit and Overhead Trolley Tramway in Washington (Illustrated description). Ry Wld-Sept. 900 w.

*8158. The Working Expenses of Electric and Cable Railways (Tabulation of figures from various English roads, with analytical comment). Ry Wld-Sept. 1900 w.

8260. The Hirschberg-Warm-Springs-Hermsdorf Gas-Road (Description of construction, equipment and projected operation of a road using gas-engine motors. The cost is said to be very low. Illustrated with maps of the line, and rail sections). Pro Age-Sept. 15. 2000 w.

8266. Power from the Trolley Circuit—Is it Practicable? Why Do the Fire Insurance Companies Object? What Should be Done to Overcome the Objections? H. S. Newton (Argues in favor of the policy as economical and remunerative, and considers insurance opposition unwarranted and remediable). Elec Wld-Sept. 19. 1600 w.

8267. The Daily Inspection and Care of Car Equipments. James B. Cahoon (Paper read before the N. Y. State Ry. Convention. Advocates rigid daily inspection, and suggests a plan therefor). Elec Wld-Sept. 19. 1600 w.

8276. Street Traction in France (From the *N. Y. Evening Post, Sept. 5.* Reviews the situation and the causes favoring and opposing electric, compressed air, and cable traction respectively). Elec-Sept. 16. 1200 w.

8279. New York Street Railway Association (A report of the annual meeting, with abstracts of communications and discussions). R R Gaz -Sept. 18. 2300 w.

*8298. Standards for Rating Apparatus. W. J. Clark (Abstract of paper presented to N. Y. State Street Ry. Assn. Suggestions upon the more thorough standardization of electrical railway apparatus). St Ry Rev-Sept. 15. 1200 w.

*8299. Selection of Motormen and Conductors (Summary of methods employed by various companies; compiled from correspondence). St Ry Rev-Sept. 15. 2300 w.

*8300. Trolley Parties and Party Cars (A compilation of correspondence from managers of various roads, describing their practice regarding this feature of operation). St Ry Rev-Sept. 15. 2200 w.

*8301. The Matter of Transfers. J. H. Stedman (Abstract from a paper read before the N. Y. State Street Ry. Assn. A discussion of the expediency of a liberal transfer system). St Ry Rev-Sept. 15. 1200 w.

*8302. Construction and Maintenance of Electric Street Railway Tracks. George H. Neilson (Abstract of paper read before the Penna. State Street Ry. Assn. A brief discussion of established points in city and suburban construction). St Ry Rev-Sept. 15. 2200 w.

*8303. Long Distance and Heavy Duty Electric Railways. F. W. Darlington (Paper read before the Penna. Street Ry. Assn. A discussion of established facts and mooted points as to general policy). St Ry Rev-Sept. 15. 4000 w.

*8304. How Can We Prevent Accidents and Increase the General Efficiency of Employés? W. W. Cole (Read before the N. Y. State Street Ry. Assn. Discusses as means of safety, principally the qualifications of employés, inspection of equipment, careful examination of schedule, and high standard of construction). St Ry Rev-Sept. 15. 1200 w.

*8305. The Use of Old Rails as Underground Conductors. F. O. Rusling (Read before the N. Y. State Street Ry Assn. Discussion of the advantages and limitations of the system). St Ry Rev-Sept. 15. 1200 w.

8316. Street Railways in the Empire State. G. Tracey Rogers (Address before the Street Railway Assn., reviewing notable features of the New York lines). W Elec-Sept. 19. 3000 w.

8360. Report on Rails for Street Railroads. C. L. Allen (Read before the Street Railway Assn. of the state of N. Y. (Recommendations for general specifications). Elec Rev-Sept. 23. 1000 w.

8382. Staten Island's Railway System (Illustrated description). Elec Eng-Sept. 23. 1500 w.

8385. Trolley Line between Lakes Erie and Ontario. Orrin E. Dunlap (Brief illustrated description). W Elec-Sept. 26. 600 w.

8392. The Efficiency of Railway Motors. William Baxter, Jr. (An article aiming to show the superiority of electricity to compressed air for traction purposes). Elec Wld–Sept. 26. 2000 w.

8422. The Pole Gas-Motor Street Car. T. C. J. Baily, Jr. (Description of construction and trial of an experimental motor-car). Eng News–Sept. 24. 600 w.

8510. Compressed Air vs. Electric Motors. (Letters from Edward W. Serrell and Ira Harris, reviewing the comparative advantages and defects with conclusions favorable to compressed air). R R Gaz–Oct. 2. 2800 w.

8536. General Track Construction and the most Approved Method. C. Loomis Allen (Abstract of paper before the N. Y. State R'way Assn. advocating high carbon steel rails and giving recommended specifications for composition, with notes of discussion). W Elec–Oct. 3. 900 w.

8538. Willow Grove Park and Electric Road. Herman S. Hering (Illustrated description of a road and amusement park which has proved a successful investment). Elec Wld–Oct. 3. Serial. 1st part. 3300 w.

*8603. Liverpool Overhead Railway. S. B. Cottrell (Read before the British Assn. for the Adv. of Science. Describes construction, signals, extension, equipment, etc). Elec Rev, Lond–Sept. 25. 4400 w.

8648. Electric Traction on the Third Avenue "L" Road, New York (Illustrated description of the methods of operation to be introduced on the 34th St., branch). Elec Wld–Oct. 10. 1300 w.

Equipment and Equipment Maintenance.

8150. The New Express Engines of the North Eastern Railway, England (Brief description with drawings and details). R R Gaz–Sept. 11. 900 w.

*8157. The North Eastern Railway Company's Latest Express Engines (Description, details and sectional drawings). Ry Wld–Sept. 350 w.

*8170. Some American Locomotives (Brief note and illustrations of American engines built for Spanish American roads). Eng, Lond–Sept. 4. 150 w.

8262. Oil Burning Locomotives (Description of engine in use on the Pacific coast, with sectional drawings of fire box and oil-tank. Oil burning is said to be merely a question of economy not of mechanical success). Ry Age–Sept. 11. 700 w.

*8295. Locomotive for 2-ft. Gauge Railway (Sectional drawing and details of principal dimensions). Engng–Sept. 11. 600 w.

8420. 60,000-Lb. Box Car for the Baltimore & Ohio R. R (Description with measurements and detail drawings). Eng News–Sept. 24. 600 w.

8427. Compressed Air in the Shops of the Missouri Pacific Railroad. H. N. Latey (Description of practice and illustration of devices). R R Gaz–Sept. 25. 1600 w.

*8514. Some Odd Locomotives Recently Turned out by the Baldwin Locomotive Works (Illustrations and very brief description of some unusual types for special duties). Loc Engng–Oct. 500 w.

*8515. Remodeling of 40,000-Lb. Cars (Brief description of a method of remodeling 40,000-lb. box cars into 50,000-lb. cars. Drawings of some of the details). Loc Engng–Oct. 1100 w.

*8528. The Use of Buffer Blocks with Vertical Plane Couplets (Brief citation of the overlooked advantages to be derived from their use). Am Eng & R R Jour–Oct. 800 w.

Maintenance of Way and Structure.

8272. Tie-Plates (Report of the Committee on Roadway, Am. Soc. of R. R. Supts., with correspondence. The report is highly favorable to the tie plate for safety and economy). Eng News–Sept. 17. 6500 w.

8274. Convention of the Roadmasters' Association of America (Report of convention, with special reports and discussions on facing point switches, ditching, rail joints, ballast, etc). Eng News–Sept. 17. 6500 w.

8277. A Modern Railway Span (Drawings and description of a typical span, with comment on the gradual assimilation of English and American types). Ry Rev–Sept. 12. 1200 w.

8437. Ballast Crushing Plant Illinois Central Railroad (Illustrated description). Ry Age–Sept. 25. 350 w.

Signaling.

8261. Signaling and Interlocking in Chicago (A description of the Chicago & Northern Pacific Plant at Grand Central Station). Ry Age–Sept. 11. 600 w.

8421. Block Signaling and Interlocking (Abstract of discussion at the meeting of the American Society of Railroad Superintendents, at Niagara Falls). Eng News–Sept. 24. 1400 w.

8438. The Electric Train Staff (Abstract of Mr. Charles Hansel's paper before the Am. Soc. of R'way. Supts., at Niagara Falls. Illustrated). Ry Rev–Sept. 26. 3000 w.

8440. Is the Switch and Lock Movement Safe? W. H. Elliott (A paper read before the Railway Signaling Club. The position taken is that the movement is reasonably safe when used in connection with the bolt lock). Ry Rev–Sept. 26. 1500 w.

8511. Interlocking at Paoli, Pa. (Brief descriptive account, with diagram, plan of rods and wires, etc). R R Gaz–Oct. 2. 700 w.

Transportation.

8152 Rapid Transit—Analysis of One Day's Traffic of the Manhattan Railway, New York City. Theodore Cooper (The analysis is very full, and is illustrated by tabular and graphic charts). R R Gaz–Sept. 11. 2500 w.

8296. Injunction Against Rate-Cutting (Summary of the petition in the new proceedings and of the order of Judge Speer granting the injunction). Ry Age–Sept. 18. 1000 w.

8426. The Economy of Express Trains on Urban Railroads. William Barclay Parsons (Strongly advocates the express system. Arguments based upon New York rapid transit experience). R R Gaz–Sept. 25. 2200 w.

8433. Interstate Commerce Commission Hearing at Chicago (Abstract of cases and evidence presented). Ry Age-Sept. 25. 1400 w.

8435. Handling of Switching Charges (Proposed method of disposing of these troublesome accounts). Ry Age-Sept. 25. 1200 w.

8436. Pooling of Freight Cars (Mr. Cavanagh's plans explained in answer to enquiries). Ry Age-Sept. 25. 900 w.

Miscellany.

*8123. Fast Trains as Related to Business Policy. H. G. Prout (Discussing the relation of increase in train-speed to increase in passenger-traffic). Eng Mag-Oct. 4300 w.

8151. Maine Railroad Commissioners Refuse an Electric Railroad Application (The application was opposed by a steam road, and the application was denied on the ground that public convenience did not require the new line. Abstract of the report is given, and editorial). R R Gaz-Sept. 11. 2800 w.

*8154. The Burgenstock Rack Railway (Description of a notable Swiss road). Ry Wld-Sept. 1400 w.

*8155. The Liverpool and Manchester Railway (Historical review, with illustrations of original line and equipment). Ry Wld-Sept. 1500 w.

*8166. An Egypto-Assyrian Railway as the New Overland Route to India. A. T. Fraser (A representation of the enormous importance to England of connecting Ismailia by rail with the head of the Persian gulf). Jour Soc of Arts-Sept. 4. 2000 w.

†8196. Indian Railway Policy (Criticism of the vacillating policy, alternating between government operation and company working under government guarantee, and recommendation of management under a few large companies). Ind & East Eng-Aug. 15. 2800 w.

8204. A Comparison of Three Locomotives—Two American and One English. M. McCabe (The comparison is based on scientific calculations from partially assumed data, and is very favorable to the American types, but strong emphasis is laid upon the necessity of greatly improving the steam locomotive). Age of St-Sept. 12. 900 w.

8273. Convention of the American Society of Railroad Superintendents). Brief report of annual meeting, with abstract of committee reports on electric locomotives, and tonnage rating of freight trains). Eng News-Sept. 17. 2000 w.

8278. The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers. W. F. M. Goss (Gives the result of experiments, with tables and charts. The most efficient action is shown to accompany the lowest rates of combustion, and the reasons given). R R Gaz-Sept. 18. 1700 w.

*8293. The Glasgow Central Railway (The first part sketches the projected enterprise and its territorial relations, with description of the plans adopted for station building. Sectional plans are given). Engng-Sept. 11. Serial. 1st part. 2500 w.

8297. The Motive Power of the Future (Takes the ground that with advancing improvement in mechanical applications, electricity will supplant steam, which, according to this article, has reached the limit of practicable perfection in the locomotive). Ry Age-Sept. 18. 1200 w.

*8306. The Railway Year in New Zealand (Tabulation and review of earnings, mileage, traffic, etc). Trans-Sept. 11. 1500 w.

*8311. The Snowdon Mountain Tramroad (Correspondence reviewing the accident, and discussing causes and preventive measures). Eng, Lond-Sept. 11. 3000 w.

8380.—$1. A Re-survey of the Williamsport Division of the Philadelphia and Reading Railroad. George D. Snyder (Abstract of a paper accepted by the Committee on Publication for filing in the library of the Society. The method used is explained and its advantages stated). Am Soc of Civ Engs-Sept. 1600 w.

8428. Train Accidents in the United States in August (Classified table with editorial comments). R R Gaz-Sept. 25. 3000 w.

*8430. Japanese Railways (Analysis and discussion of an official report by the British Sec'y. of Legation at Tokio. An impending boom is predicted, and English manufacturers urged to combat growing American influence). Engng-Sept. 18. 2500 w.

*8432. The Railways of New South Wales (A review of the year's results, revenues, expenditures and rates, with some general comment). Trans-Sept. 18. 1400 w.

8512. Telegraph Construction on English Railroads (Abstract of a paper by W. Langdon, read before the Inst. of Elec. Engs., summarizing English practice, and of the ensuing discussion). R R Gaz-Oct. 2 1500 w.

8513. Some Speculations About the Economy of Locomotives Under a Variable Load (Formulæ, table and diagrams from Prof. R. C. Carpenter's paper befoie the A. I. E. E). R R Gaz-Oct. 2. 1200 w.

*8516. The Traveling Engineers' Convention (Brief report with abstract of reports and discussions). Loc Engng-Oct. 7000 w.

*8526. A Few Facts and Opinions on the Design of Express Locomotives (Notes of the London meeting of the International Congress, cited to show prevailing ignorance of American practice). Am Eng & R R Jour-Oct. 1500 w.

†8617. Statistics of Railways in the United States (Eighth annual report on the statistics of railways in the United States for the year ending June 30, 1895. Prepared by the statistician to the commission). 17500 w.

8618. The Aylmer Branch of the Canadian Pacific Railway Operated by Electricity). Description of the equipment and operation of a connecting link road handling considerable traffic). Elec Eng-Oct. 7. 700 w.

8622. A Russian Railway Official (Biographical sketch of Prince Michael Hilkoff, imperial minister of ways and communications of Russia, with considerable side light on Russlan railway matters). Ry Rev-Oct. 3. 2500 w.

SCIENTIFIC MISCELLANY

General Fire-Fighting.

THIS was the title of a paper prepared by Mr. Simon Brentano of New York, and read at the seventeenth annual convention of the Massachusetts State Firemen's Association, held at Brockton, September 18. Mr. Brentano is a merchant, and in no way connected with any fire department, but he has made the subject of fire-fighting a special study. Captain Needham, of the New York fire department, who read Mr. Brentano's paper at the convention, spoke of Mr. Brentano as one " whose interest in all matters relating to fire-extinguishment was of the most enthusiastic kind, as a frequent and earnest observer of New York fires, and as a gentleman very popular with the New York fire department."

The paper is printed in *Fire and Water* (Sept. 26), from which we derive the following abstract.

Mr. Brentano regards the distinction between the earlier and more modern methods of fire-fighting as lying principally in the fact that, in the modern methods, the control of a fire is made paramount to mere extinguishment. In the earlier methods the aim was to extinguish rather than control. The modern method regards the extinguishment of a fire as incidental to control. What is here meant by control of a fire is defined as " its restriction as nearly as may be possible, under the varying circumstances attendant upon and surrounding each fire, to the actual point of origin, or to keep it within that boundary which the fire had attained at the time of the arrival of apparatus. In some instances this means that the fire will be confined to the room and to the actual incipient blaze which ignited a window curtain ; in others, it will mean the complete destruction of the building in which the fire originated ; again, in others, it may mean the ignition and destruction of neighboring and adjacent buildings. But at no time has the experienced fireman lost his sense of control, nor have his plans changed, except by reason of those changes forced upon him by the apparent gain of the fire over all control for the time being. But in such cases companies are assigned to new positions, the lessening points of danger abandoned, the more menacing position is strengthened, and that disposition is made in detail that evinces sagacity, the quick and ripened judgment of the fireman, and that throughout illustrates the underlying object to be achieved,—namely, the control of fire. Against what fearful odds the control is often won is familiar to you all. It must often have impressed itself upon your mind, reflecting over the changing conditions that have existed during the course of some of the fires at which you have performed duty, how the careful assignment of one company may have been the key-point, or, in other words, determined the control of a fire. The control of fire should not at any time be confused with the actual extinguishment of fire. I have seen fires far more destructive than the occasion warranted, by reason of the fact that the proper estimate was not placed upon the chief element attaching to every fire,—namely, a correct judgment as to its control. To illustrate this by familar example, I need only point out that many fires gain and cover an area larger than they should, because upon arrival the companies, or those in charge of them, fail to recognize that the original point of fire is beyond instant control ; but, in the mistaken effort to extinguish this original source of fire, instead of keeping it in check, it permits the fire to extend. The inability to view a fire and to determine at once whether or not the greater effort should not be extended to surrounding risks rather than the immediate fire itself forms one of those errors of judgment in practice which have been, and will continue to be, a serious cause of unnecessary fire-loss. Of course, the control of a fire, I need not say, should be effected with the greatest celerity possible. It is, of course, a simple and fundamental law of fire-extinguishment that the danger of destruction is lessened with each moment gained in the control. Most fires attain their maximum in relatively short time. I have timed several very serious fires, and I have estimated that they have reached their maximum danger-point in thirty-five to fifty minutes; after that time the fire was a receding one,—that is to say, the control over it was becoming manifest. A fire which one hour after its inception is burning as fiercely or as dangerously and shows no sign of abatement is a most serious fire and portends great danger,—of course, I except from this classification structures completely isolated, certain oil fires, and lumber fires,—but in the main the visible signs of gain should be present in thirty-five to fifty minutes. I have seen a very dangerous fire in a five-story building about fifty by seventy-five feet, where the fire originated on the third floor and at once assumed large proportions, controled in exactly fourteen minutes, although the actual duty of fire-extinguishment kept a sufficient number of companies busy for five hours subsequently."

As to fire-extinguishment the rule to be followed is to bring the "water to bear as nearly as possible to the actual seat of fire or combustion. . . . The most efficient use of water is when the stream is directed at a range as close as practical conditions will permit to the actual seat of fire." Mr. Brentano does not think that pressure can compensate for want of sufficient volume in fire-extinguishment. He seems to think, however, that pressure *per se* performs a valuable function in putting out a fire, but for this opinion he declares himself yet unprepared to assign a reason.

The Preservation of Data by Photography.

THE tedious work of hand-copying with a pen is a burden from which the civilized world has long wished relief. Copying presses, typewriters, and numerous processes for producing copies of script are in evidence of this desire. No better example of drudgery-work pure and simple, and utterly devoid of interest, could be found than the hand-copying of documents. Not only the mind is unexercised, but the body also, and to an active mind work of this sort is inexpressibly tedious.

In the collection of data scientific and professional men require a great deal of copying to be done, and, as, in writing formulæ, etc., it is not safe to trust the uneducated persons who usually do copying because they are incompetent for anything better, collectors find it necessary to do at least a fraction of the work themselves.

Mr. Reginald A. Fessenden, in *The Electrical World* (Aug. 22), describes a method for avoiding much of this drudgery by the use of photography. He says he has used this method for more than a year, and it proves so satisfactory that he now gives it out to the professional world as a great convenience to collectors of data. The use of photography has enabled him, not onlv to copy mathematical expressions, but diagrams and illustrations, with great rapidity and perfect accuracy.

Having first tried the library-card system, he found that many times he wished to copy down more matter than would go on one or two cards.

The method of photography, while it has been used, has not hitherto been reduced to a system. Mr. Fessenden, however, has devised a plan which he explains with the aid of half-tone engravings, which should be consulted in the original paper by persons who wish full details. Suffice it to say that the entire arrangement is attached to the desk of the user. An ordinary roll-top desk is shown in the illustrations. When it is desired to copy a page, it is placed on the flat surface of the desk, a sensitive plate is placed in a camera specially made for the purpose, having one and one-fourth inches focus, and a lens of one-fourth inch aperture, and working about twenty-five times as fast as the ordinary photographic lens with the usual stop, and taking in a wide angle. For objects over two feet away it needs no focusing. The operator then pulls downward a chain attached to the camera to a distance corresponding to the size of the surface to be copied. The camera being thus brought into the proper distance, an exposure of ten seconds is given to the plate, and the plate-holder is put away till a convenient opportunity for development. The paper need not lie entirely flat on the desk, and requires very little care in its adjustment. Each plate is one and one-fourth by one and one-half inches.

On a plate of this size two thousand words may be printed so that they can easily be read by a small magnifying-glass, and five hundred words on such a plate may be read by a person of average eyesight without the aid of a glass. This seems an astonishing statement, but the author goes much further. The theoretical limit of reading without a microscope of the highest power is stated to be 150,000,000 words per square inch. The author tacitly admits that this is likely to stagger belief. We quote his concluding words:

"This is almost inconceivable, for three hundred volumes of a thousand pages each is a fair-sized library. But the only thing that till recently stood in the way of its practicability—*i. e.*, the coarseness of the grain of ordinary photographic plates—has been removed by Lippman in the beautiful experimental work by which he has made Rayleigh's proposed method of taking colored photographs by interference methods an accomplished fact.

"Even with a magnification of thirty diameters, instead of the six hundred which I have assumed in the previous calculations, one such volume would go on a plate one inch square. At this rate a box one foot cube would contain a library of 50,000 volumes, or 1,500,000 with the larger magnification.

"However startling this may seem, it is not impracticable, at least for the lower power mentioned; and it is well within the bounds of possibility that the scientific student of the future will do his book work with the aid of a small projection lantern and a library of small positives, purchased at a small fraction of the price now paid. The thing is infinitely more practical than the proposition, seriously made and received, that phonograph cylinders should take the place of books. It would take a man five years, reading at the rate of one hundred and fifty words per minute for ten hours per day, to utter the words which may be contained on a piece of glass one inch square, while, as regards ease of reference to a particular part of a work, there is no comparison. It would be an extremely easy matter, for instance, to arrange the mechanism of a plate containing a German dictionary so that, by the pressure of a couple of keys, the page commencing with any given letters would be thrown on the screen instantly."

There is much in this article to stimulate imagination and to indicate possibilities. And, though some of the statements made may seem extravagant to those not familiar with the use of the camera and microscope, they are, we think, all capable of verification.

The Underground River of New England.

WE find in the *Boston Journal of Commerce* (Sept. 26) an account of this remarkable underground stream, whose existence was first announced by the late Professor Denton of Somerville, Mass., some eighteen years ago, the statement being then received with very general incredulity. The discoverer said that this stream contained the purest water, and deemed it adequate to "supply all central New England for all time." The discovery was made by Professor Denton while searching for a supply of water sufficiently pure for use in a Foxboro (Mass.) hat factory for bleaching the material for fine summer hats.

The *Journal of Commerce* says that the discovery remained a secret with Professor Denton for a long time. On the south side of Foxboro there are several natural ponds, one of which is called "Witches' pond," from its peculiarities. This pond contains several springs of great size and has no visible outlet.

"Witches' pond was so named years ago, on account of the many peculiar noises heard there. At intervals there were distinct rumblings beneath the surface. Superstitious persons were alarmed, and afraid to go near it. People who had no fear of ghosts watched the action of the water with interest. They always found the water icy-cold in summer, and it ever rolled and boiled. A water-pail would not cover the largest bubbles.

"The pond covers fifteen acres, and in winter ice forms there long before there are signs of ice on other ponds. Ice six inches thick forms on Witches' pond to every inch of ice on other ponds in the vicinity in the same length of time. Only a few years ago four men who were fishing through the ice narrowly escaped losing their lives. There was a sudden upheaval while the men were on the pond, and ice fourteen inches in thickness, that covered the peculiar lake, was thrown about. The men, having heard the internal rumblings, took warning and reached the shore just in time to avoid being precipitated into the boiling pond. Lily-pad roots as large as one's arm were brought to the surface at the same time.

"Professor Denton heard several stories about the pond, and out of curiosity made an investigation into the cause of the great boiling of the water which occurred at intervals. He tried to take soundings, but in several places he was unable to find the pond's bottom. Gases were detected rising from the pond, and he was led to believe that they issued from some distance below the surface. The water's remaining pure proved to him that the pond had an outlet as well as a source, and, as it was not visible, the investigation was all the more interesting.

"Pipes were driven about the well, and coal and blue clay were brought to the surface. Over one hundred feet below the level the pipe struck a ledge, and, after drilling the ledge on the south side of the pond, water was found. The water, when examined, was found to be purer than any other found in New England. Several wells were driven, and Professor Denton came to the conclusion that Witches' pond was an outlet for an underground river. It was when he told of his discovery that people laughed at him.

"The river located was one hundred and ten feet below the level. Above it was a covering of hard pan, and the bottom, twenty feet below the covering, was of rock. Professor Denton was of the opinion that there was no Witches' pond until there was an upheaval of the earth years ago, when the shelving rocks under and over the torrent were torn away. Aided by gases from the coal and other substances in the earth, a rent was torn, through which the water made its way to the surface.

"The streams in the vicinity of Foxboro are from a different water-shed. The underground river is believed to come from a glacial spring in the White Mountains of New Hampshire, or beyond. It is known that the city of Lowell struck the river only a few years ago, and from that day to this has had a fine supply of water. At the time the Lowell wells were driven no one had heard of the river flowing under New England from north to south. The underground current has been followed by wells through Attleboro, Dodgeville, and Hebronville, to Lebanon, where it swerves to the west and passes under Pawtucket falls on the Blackstone river, thence through Pawtucket southwesterly and under Providence, Cranston, Warwick, East Greenwich, and Wickford into North Kingston, and into the sea near Hazard's ledge."

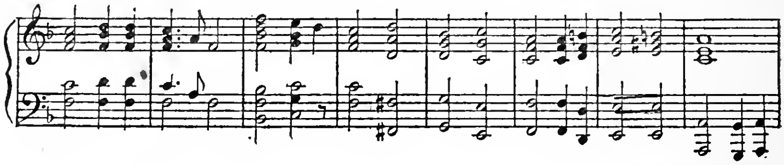
Not far from the time that this river was discovered a large bleachery in Providence drove a well which yielded a never-failing supply of very pure water, doubtless from the same source as that of the water-supply of Lowell. The New Haven & Hartford railroad have struck the stream by wells at Pawtucket. The water is said to be better than ordinary spring water, and admirably fitted for use in steam boilers.

The Rivoire Music-Registering Apparatus.

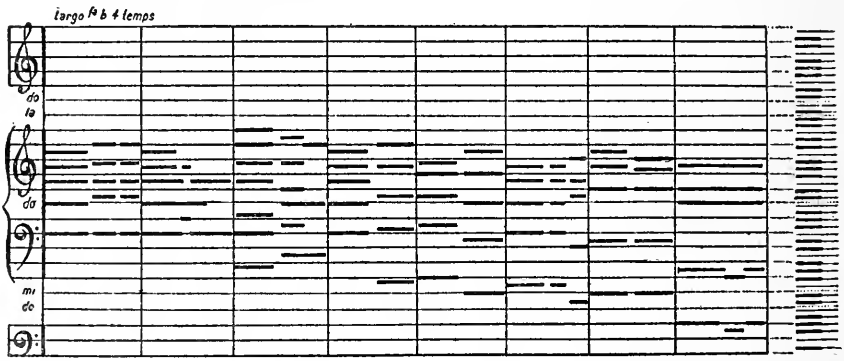
THERE seems to be scarcely any limit to the resources of mechanicians. Let almost anything be required to be done mechanically, and there are plenty of mechanicians who will attempt the task, and some who will accomplish it. Among the ingenious mechanisms of modern times (not less ingenious because it is simple) is the music-recording apparatus herewith illustrated. One of the cuts represents the mechanism employed; the other shows the notation of which the interpretation is shown superimposed. Those who read music will find very little difficulty in reading the record of the performance. A musician to whom we showed it after explaining the principle of notation had no difficulty in reading it at sight.

We condense the description from an article reprinted in *Scientific American Supplement* (Oct. 3) from *L'Illustration.*

"If the composer places his finger upon a key, the pressure that he exerts actuates the rod, B. A lever, C, gives another steel rod, D, parallel with the first, an up-and-down motion. To the extremity of D there is adapted a transmitting rod, E, that gives an up-and-down motion to a rod, F, which is provided at its extremity with a wheel, M, that is always kept inked by an appropriate arrangement. A pressure upon the key gives an up-and-down motion to the wheel, M, through the series of rods and levers. A clockwork movement unwinds, at the uniform speed of fifty inches a minute, a band of paper



FIRST MEASURE OF THE RUSSIAN NATIONAL HYMN.



NOTATION OF THE ABOVE MUSIC UPON THE REGISTERING APPARATUS.

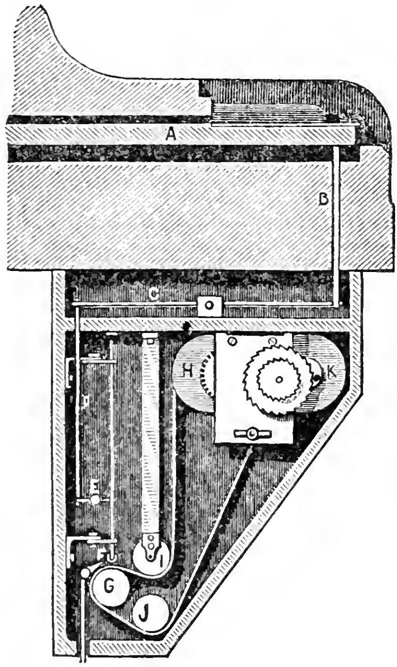
"The apparatus is inclosed in a wooden box under the keyboard. Under each key it suffices to form an aperture in the bed of the piano for the passage of a rod that transmits the musical thought to a pen through the mechanism described. Such preparation permits of applying the apparatus to all pianos.

"Suppose the composer is at the piano; a simple ungearing starts the apparatus, and causes the rod to rise and abut against the key. If the rod is lowered, the piano returns to its normal state, and the apparatus is at rest.

wound upon the roller, K. This band passes over the cylinders, G, I, J, the object of which is to put it in contact with the pen, F, when the latter is actuated. Then, after it has received the signs thus automatically inscribed upon it, the band winds around the receiving cylinder, H, whence it may be unwound in order to read or criticise the finished improvisation. In measure as it unwinds, the band is regulated mechanically by a series of dashes in the direction of the motion. The interrupted dash of the center represents the do that separates the key of sol from the key of fa. The other dotted lines, la and do in the key of sol, and mi and do in the key of fa, are register marks.

"The reading of this new method of musical inscription is done in about the same way as that of the music that we ordinarily decipher, each note occupying in the two writings an identical place upon the stave; only, flats and sharps are determined by the position that they occupy, and not by the aid of a particular annotation, and they always find a place in the interlines. Every note touched will be inscribed upon the band of paper in the form of a dash whose length will determine the rhythm. The reading of the inscription thus obtained is easy to a skilled musician. Those not skilled may use a small movable cardboard keyboard, proportioned to the width of the band of paper, to cover each note stenographed upon the band. But the use of this device will soon become useless to whoever has familiarized himself with the operation of the apparatus. In fact, he will soon learn to read the open band, and will disdain the use of a measure bar, which is maneuvered with the left foot and which permits of the decomposition of the musical inscription into measure and time.

The band unwinds at the speed of fifty inches a minute, and, being two hundred and forty-six feet in length, will last an hour. The clockwork movement that actuates the mechanism needs to be wound up every twenty or thirty minutes.



MUSIC REGISTERING APPARATUS.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

kinds of explosives having nitro-glycerine for a base are treated). Can Eng–Sept. 1800 w.

*8244. Canals and Their Impurities. H. Ward (Read before the Staffordshire Sanitary Inspectors' Assn. The subject is treated with reference to the sanitation of canal waters). San Rec–Sept. 4. Serial. 1st part. 1600 w.

8263. The Columbia River Salmon Fisheries (Illustrated description). Sci Am–Sept. 19. 1600 w.

8281. Baths. G. Mendizabal (Read before the American Public Health Assn. Uses, abuses, benefits and dangers of baths. Promiscuous bathing in a common bath-tub is dangerous unless the greatest cleanliness in the care of bath-tub, towels, brushes, etc., is observed). San Plumb–Sept. 15. 1800 w.

*8291. Technical Education (English and American technical schools compared briefly). Engng–Sept. 11. 1700 w.

*8334. The Great Seismic Wave of Japan (Summarizes the particulars of this occurrence, and gives causes which have been assigned for its creation; also refers to waves of a similar character that have occurred on former occasions and in other localities). Nature–Sept. 10. 2200 w.

*8335. Application of Röntgen Rays to the Soft Tissues of the Body. John Macintyre (Illustrated account of examples obtained in this branch of the art). Nature–Sept. 10. 2800 w.

†8351. New Staffordshire Pottery Kilns (Illustrated description). Cons Repts–Sept. 1800 w.

†8353. Germany's Importation of United States Cotton (Importance of Germany as a consumer of American cotton. Faults in baling illustrated). Cons Repts–Sept. 1000 w.

8371. Apparatus for the Manufacture of Acetylene Gas (Illustrations and brief descriptions of some of the more prominent apparatus in use). From *Le Genie Civil.* Sci Am Sup–Sept. 26. 2000 w.

8395. The Fire Alarm Telegraph, General History and Latest Improvements. William Brophy (A general review of progress from 1845 to date). Fire & Water–Sept. 26. 5300 w.

8396. General Fire-Fighting, with Particular Reference to the Advisability of the Establishment of a Fire School or College in Connection Therewith. Simon Brentano (Fundamental laws of fire extinguishing. Suggestion for a school of instruction in fighting fire). Fire & Water–Sept. 26. 2000 w.

*8411. Röntgen Ray Hypotheses (The theories most in favor at the present time). Elec Rev, Lond–Sept. 18. 1200 w.

8453. Artesian Wells (Abstract of a paper by A. A. de Bonneville, contributed to the *Stevens Indicator* for July. Definition of an artesian well, the conditions necessary for such wells, and various methods for sinking or boring them). Eng Rec–Sept. 26. 1800 w.

8456. An Underground River (Remarkable subterranean stream of pure water flowing from the White Mountains, first discovered by the late Prof. Denton). Bos Jour of Com–Sept. 26. 1500 w.

*8459. Technical Education (Editorial in which the so-called "bogie" of German competition with English industry is treated as based largely upon misrepresentation). Eng, Lond–Sept. 18. 1800 w.

*8460. Monsted's Margarine Factory, Southall (Illustrated description of ammonia condensers used in this establishment). Eng, Lond–Sept. 18. 800 w.

*8506. Transmission and Photometry of X-Rays. Antonio Róiti (Investigations on X-ray phenomena). Elect'n–Sept. 18. 1800 w.

*8507. On Tubes for Producing X Rays. Augusto Righi (Explains an easy and speedy method of constructing tubes for X rays with which remarkable effects may be obtained). Elect'n–Sept. 18. 600 w.

8537. Röntgen-Ray Tubes. W. M. Stine (The writer states that no standard form of tube has yet been evolved nor is one needed. He gives minute details for the construction of glass-impact tubes, and shows that by the method of reversal it is possible to completely restore a tube to its original condition without heating or re-exhausting. Also discusses metallic-impact or focusing tubes, and their working). Elec Wld–Oct. 3. 2200 w.

*8567. Technical Education. Sidney H. Wells (A critique upon an editorial on this subject which appeared in *Engineering*, Sept. 11, maintaining that the editorial referred to gives a false impression and does a grave injustice to a great and important educational movement). Engng–Sept. 25. 1700 w.

†8585. Modern Theories of Fermentation, with Notes on the Morphology and Culture of Yeasts. Dr. Francis Wyatt (A dissertation upon germs and the life history of micro-organisms). Jour Fr Inst–Oct. Serial. 1st part. 5800 w.

†8588. On a New Process for the Manufacture of White Lead. William Tatham (A brief résumé of pre-existing methods is followed by a description of the new method, which is extremely simple and gives a product almost exactly like the best Dutch white lead). Jour Fr Inst–Oct. 1800 w.

8643. The Louisiana Sulphur Wells. J. B. Frauckhauser (Illustrated description of the wells and of Frasch's method of pumping up sulphur liquefied by heat). Sci Am–Oct. 10. 1000 w.

8646. Some Recent Röntgen Ray Work. Elihu Thomson (Illustrated description). Elec Wld–Oct. 10. 800 w.

†8654. The India-Rubber Business in Trenton. W. H. Dunbar (A résumé of the rubber industry in this city). Ind Rub Wld–Oct. 10. 1700 w.

†8655. India-Rubber in British Official Reports (A comprehensive array of India-rubber statistics). Ind Rub Wld–Oct. 10. 1800 w.

†8656. The Rubber Tire Association (An important organization, embracing most of the manufacturers of tires in this country). Ind Rub Wld–Oct. 10. 800 w.

THE

ENGINEERING MAGAZINE

VOL. XII. DECEMBER, 1896. NO. 3.

THE NEW ERA OF PROSPERITY.

A NOTABLE SPECIAL NUMBER OF THE ENGINEERING MAGAZINE.

THE newly-elected President of the United States has been heralded as "The Advance Agent of Prosperity." The campaign for his election was fought out on the pledge that his triumph would restore the prosperous conditions preceding the panic of 1893, and bankers, merchants, manufacturers, and business men generally, irrespective of party, united with the politicians in predicting that the defeat of free silver and the triumph of the gold standard would restore confidence, dissipate the gloom of uncertainty as to the future, and inaugurate a new era of prosperity.

As the campaign progressed and the success of the sound-money cause seemed more certain, we first saw panic driven from the stock exchanges by a steady and irresistible advance in values. Next came the news of an unprecedented increase in the volume of our export trade,—so great indeed that the available ships were inadequate to carry it, and in many instances freight rates were doubled. This was followed by heavy importations of gold, coming with every ship and measured by weekly aggregates of tens of millions of dollars. Then came the enormous advance in the price of wheat, showering happiness as well as profit upon American farmers, and forever dispelling the delusion that the price of that cereal is controlled by the value of silver. And finally, with the result of the election definitely known, we have seen the newspapers filled with despatches from every section of the country telling of the resumption of work by mills and factories of every description, giving profitable employment to hundreds of thousands of idle workers; the hoarded gold is still flowing into the banks; the treasury gold reserve is rising steadily; municipal bonds sell freely at high premiums; the rates for money have dropped to the normal point; and capital is freely advanced for every legitimate commercial and industrial enterprise.

This is cheering news, and happily there is enough of it to show that the discontent born of hard times must surely be dispelled by the logic of prosperity. But, after four years of panic and depression, prudent men are disposed to go slowly,—to ask for further information. Before large enterprises can be undertaken, before money can be laid out in needed extensions and improvements, there are leading questions yet to be answered. What are the underlying causes of the present prosperity? Is it due to the great natural laws of commerce and industry, and will it last? Or is it due to purely sentimental causes of temporary influence? Will the free-silver advocates be able to disturb confidence two years hence? Is the country in a healthy condition, commercially and industrially? What is the status of our great railroad systems? What is the outlook in the building world? Is the mining industry likely to be prosperous? What of the electrical field? And what are the prospects throughout the varied machinery-making and mechanical trades?

To meet the demand for information upon these and a score of kindred subjects, THE ENGINEERING MAGAZINE begs to announce, for its next issue, a special PROSPERITY NUMBER, the purpose of which will be to review the whole broad field of American economic and industrial affairs—present and prospective.

In this preliminary announcement it will not be necessary to indicate the scope and purpose of each article. Suffice it to say, that the matchless resources and grand opportunities of the United States as compared with all the older nations of the earth will be graphically set forth by one of the most eminent economists now living; the far-reaching significance of the advance in prices for farm products, and the recent importations of gold, will be clearly indicated by a statistician of the most distinguished attainments; and the outlook in each of the larger channels of industrial activity will be comprehensively reviewed by men of wide reputation, each of whom is in a position to intelligently forecast the probable conditions in his own field.

We are gratified in being able to promise a most stimulating array of facts in support of the wide-spread belief in coming prosperity, and we are especially gratified in having been able to draw to our aid for the occasion a corps of distinguished contributors, who will speak with such authority that the work is destined to play an important part in our industrial future. Indeed, it will be a volume of priceless value to every man of business who has money to invest, improvements or extensions to consider, or professional advice to be employed.

LABOR RIOTS AND SO-CALLED "GOVERNMENT BY INJUNCTION."

By Leonard E. Curtis.

ONE of the most vital issues of the presidential campaign which has just closed has received less attention than it merited, because of the over-shadowing importance of the main issue relating to the financial policy of the nation.

For the past twenty years labor disturbances have been among the most conspicuous features of our industrial development, and it has been a matter of increasing difficulty, in view of the magnitude of the interests involved and the bitterness of the passions aroused, to maintain law and order and at the same time hold an even hand in respecting the rights of the contending interests to enforce their demands by lawful means. One of the planks of the Democratic platform adopted at Chicago, which has been referred to as the "free-riot plank," related to this subject, and was intended especially as a denunciation of the method adopted by the federal government for dealing with a labor disturbance at Chicago some two years ago. As this matter does not seem to have been well understood, and as very many persons, even among those who heartily approved of the action that was taken, have been disposed to regard it with too much of an air of apology,—as a thing which had to be done, but which was in the nature of a war measure and really somewhat revolutionary in its character,—I have been asked to contribute to THE ENGINEERING MAGAZINE a discussion of the matter, with a view to explaining some points connected with it and leading those vitally interested in the question to examine it for themselves more carefully.

Some two or three years ago a labor organization known as the American Railway Union came into great prominence. It comprised in its membership a large proportion of the employees of a great number of railways, including the principal trunk lines extending from the Pacific as far east as Chicago, and some of those extending considerably farther east. Strikes of railway employees had been rather frequent prior to that time, but had for the most part been unsuccessful in enforcing the demands of the men ; and this organization was formed on much broader lines, with the idea that concerted action on all the principal railways would give the employees control of the situation, and enable them to dictate terms to the railway companies. The leading spirit in this organization, and its president, was a young man named Debs, a man of boundless ambition and audacity, and of considerable ability as an organizer and a demagogue. In the summer of 1894 a strike occurred at the works of the Pullman Company near Chicago, and Debs and his associates seized upon this with apparent avidity as a pretext for declaring war against the railway companies. The resulting disturbance was not, in the ordinary sense, a strike, since the members of the Railway Union did not profess to have any substantial grievance against the railway companies; it commenced, rather, as a boycott, the American Railway Union announcing to the railway companies that, unless the companies refused to haul Pullman cars on their trains, the men would quit work. This was, of course, a demand to which the railway companies could not yield, as Debs and his associates well knew, without practically putting the control of the railways into the hands of the employees. The railway companies were under contract with the Pullman Company to haul the cars, and the cars were necessary for their business; if they yielded to the Railway Union in this matter, which did not in any way relate to the wages of the men or their hours of labor or duties as employees, but to a matter of business management, they would have been obliged to yield in all other matters relating to the management of the roads. The officers of the railways accordingly refused to accede to the demands of the union, and a boycott was declared, which very soon assumed most formidable proportions; and the usual results —rioting, violent intimidation of new men, forcible obstruction to attempts to run trains, and destruction of railway property—ensued. Twenty-two great lines of railways centering in Chicago and running through various States of the Union were very soon practically stopped in their operations, and this resulted in great delay and, in some cases, absolute stoppage of the transportation of mails, passengers, and freight on the great through lines of railway.

For an account of the state of affairs which very soon existed we need go no further than the statements made by Debs and the other officers of the Railway Union, in a circular letter to the railroad companies, dated July 12, 1894, in which they say:

"The strike, small and comparatively unimportant in its inception, has extended in every direction, until now it involves or threatens not only every public interest, but the peace, security, and prosperity of our common country. The contest has waged fiercely. It has extended far beyond the limits of interests originally involved, and has laid hold of a vast number of industries and enterprises in no wise responsible for the differences and disagreements that led to the trouble. *Factory, mill, mine, and shop have been silenced; wide-spread demoralization has sway. The interests of multiplied thousands of* *people are suffering.* The common welfare is seriously menaced. The public peace and tranquillity are imperiled. Grave apprehensions for the future prevail."

We also have a very striking statement of the ultimate purpose of Debs and his confederates, and the methods by which they expected to attain it, in an interview with Debs, published in the Chicago *Herald* of July 15, 1894, in which he said:

Throughout that great stretch of country which lies west of the Mississippi river our men are steadfast, and willing to wait until the bitter end. You will notice that *it is impossible to buy a ticket to the Pacific coast in Chicago* to-day, except by way of the Great Northern road, over which no Pullman cars are run, and against which we have no possible grievance. This shows the line on which our future campaign is to be carried. . . . We shall persist in our work of organization throughout the east. As a road throughout the country hitherto unorganized by us falls into line, we shall call it out. And we shall keep on doing this until the very end of all things. If our present struggle, based, as it is, on motives wholly disinterested, be successful, there is no wage-earner in the land who will not feel its beneficial effects before the year closes. And, if this is true, *when the command of the so-called 'arteries of commerce' falls into our hands*, and the trade unions which have given us comfort require reciprocation from us, we, and we alone, are in a position to give them material assistance. This is an axiom, and I believe no one will disagree with me."

Debs certainly does not here overestimate the value of the "reciprocation" he would be in a condition to give when he was once in command of "the arteries of commerce," since he would then have as firm a grip on the whole country as an invading army would have on the city of New York if it had possession of the Croton aqueduct. We should have had to dislodge him at once, or surrender. An interesting glimpse of the kind of government by "reciprocation" he would have given us is afforded by an order issued by his organization to haul Mrs. Leland Stanford's private car over one of the western roads at a time when it was not permitting the trains carrying ordinary people to their business and their work to run at all.

This was manifestly a wholly intolerable state of affairs, to which an end must promptly be put if life under the conditions of civilized society was to continue.

No one appreciates more fully than the engineer the desirability of using the simplest and most direct means of doing a thing that has to be done. If a line of railway is to be built between two points, the engineer naturally selects the shortest and most direct route, other things being equal; and, if motion is to be transmitted from one part of a machine to another, the simplest and most direct connection between the parts is, other things being equal, the best.

The means chosen for putting an end to the Debs disturbance certainly left nothing to be desired as to simplicity and directness; in fact, the only complaint that has been made against what was done was that the means used were too simple and direct. The United States government had the matter brought by its proper law officers, in due form, before the federal court at Chicago having jurisdiction; the court issued an order called an injunction, commanding Debs and his associates "to desist and refrain" from interfering with, or obstructing, the transportation of the mails and the carrying of passengers or freight between or among different States; and, when proof was submitted to it that they had disobeyed the order, it sent out and got them and put them in jail, where they had no facilities for further disobedience.

A small detachment of the United States army, which had been ordered by the president to Chicago, stood by in this proceeding as a mere suggestion that seventy millions of people, most of whom were law-abiding, stood behind a chief executive who was determined to see that the constitution and laws of the United States were sustained. The bare suggestion was enough. No resistance was made to the marshals who arrested the leaders of the conspiracy.

As to the effectiveness of the means used for accomplishing the end desired, we can again appeal to the testimony of Debs himself, who testified before the United States strike commission as follows:

"As soon as the employees found that we were arrested and taken from the scene of action, they became demoralized, and *that ended the strike*. It was not the soldiers that ended the strike. It was not the old brotherhoods that ended the strike. *It was simply the United States courts that ended the strike.* Our men were in a position that never would have been shaken, under any circumstances, if we had been permitted to remain upon the field among them. Once we were taken from the scene of action, and restrained from sending telegrams or issuing orders or answering questions, then the minions of the corporations would be put to work. . . . The men went back to work, and the ranks were broken, and the strike was broken up, . . . not by the army, and not by any other power, but *simply and solely by the action of the United States courts in restraining us* from discharging our duties as officers and representatives of our employees."

The "minions of the corporations" here referred to were the thousands, and probably tens of thousands, of men who stood by, eager and willing to work as soon as the riotous intimidation organized and directed by Debs and his confederates should be ended; and the "old brotherhoods" referred to were the Brotherhoods of Locomotive Engineers and Firemen, and other solid and respectable trade unions of the railway employees, which had, from the first, refused to have anything to do with Debs's dream of empire.

As Debs states, the action of the court ended the strike; the mobs dissolved, the men who stood waiting went to work, the railways resumed operations, the mails and inter-state passengers and freight were transported as before, the mills and factories that had been compelled to shut down for lack of supplies started up again, and the business of the country resumed its normal operation.

Debs and his principal confederates were soon afterward tried by the court without a jury (as has been the established usage in such cases from time immemorial) for disobedience of the injunction order, and the court, after a full trial and the examination of a great mass of evidence, found them guilty and sentenced them to imprisonment for terms varying from three to six months. The matter was taken to the supreme court on *habeas corpus* proceedings, and that court unanimously sustained the decision of the circuit court. The defendants got out of jail in ample time to take part in the last campaign on the Bryan side, and the result of the election, especially in Illinois, where Altgeld was a candidate for governor and made this a very prominent issue, may fairly be taken as a most emphatic popular verdict in approval of the action of the courts.

Enough has been said, I think, to make out at least a *prima facie* case for the use of the injunction in such matters; but there may, of course, be another side. Just as in the work of the engineer the shortest line for a railway may not be the best one on account of its involving heavier grades or greater cost than a longer one, and a simple and direct connection between two moving parts of a machine may be incompatible with the proper working of other parts, so it may be that there are fatal objections to such use of injunctions. It was most vehemently asserted in the last campaign that there are such objections, and that the action taken by the United States government and the courts in the Debs cases was revolutionary in its character, and would inevitably lead to the subversion of liberty and the destruction of free institutions. If this is true, proper measures should be taken promptly, by proper legislation, or by amending the constitution, if necessary, to prevent such action in the future. Let us see if it is true.

As Governor Altgeld was the chief exponent of these views and summed up all that could be said on that side in his recent speech at New York, I will touch briefly on the salient points of the argument presented by him. A large part of the speech is taken up with a labored attempt to show that there was not in fact any interference at

Chicago with the mails or with inter-state commerce such as would justify the interference of the federal government, and that the disturbance was a purely local or domestic one, with which the State authorities should have been left to deal. This is entirely aside from the present question as to whether, conceding the difficulty to exist, the method employed for dealing with it was a proper one; but, as a matter of fact, it is not true that the difficulty did not exist. As opposed to Governor Altgeld's assertion, we have what we have already quoted from Debs and the unanimous decision of several circuit judges and the nine justices of the supreme court, given after careful examination of a great mass of evidence, that such interference did in fact exist to a most alarming extent.

Aside from this question of fact, the arguments Governor Altgeld attempts to make may be summarized substantially under two heads: *first*, that it was unconstitutional for the president to interfere, either throught the federal courts or by sending the United States troops to the scene, without the request of the State authorities, because the disturbance was "domestic violence" such as the State authorities should be left to deal with in the first instance; and, *second*, that the method chosen for dealing with it—that of issuing an injunction and then punishing Debs and his associates when they violated the injunction, after a trial by the court alone—was also unconstitutional and subversive of liberty, since it denied the right of trial by jury guaranteed by the constitution, and substituted for it "government by injunction," under which all of the affairs of life would "soon be regulated, not by law, but by the personal pleasure, prejudice, or caprice of a multitude of judges." The first of these propositions ignores the very foundation principles of the dual system of government established by the constitution, under which certain functions of government are assigned specifically to the United States and others reserved to the several States, and each government—the federal and the State—acts directly upon the citizens themselves, as to the function assigned to it, through its own machinery of courts, officers, and military power, without reference to, or dependence upon, the other.

The constitution expressly provides (Art. VI) that "this constitution, and the laws of the United States which shall be made in pursuance thereof, shall be the supreme law of the land," and in Article I, Sec. 8, it is provided that "the congress shall have power . . . to regulate commerce with foreign nations and *among the several States*," and "to establish post-offices *and post roads*."

In Article III provision is made for the establishment of courts of the United States which shall have jurisdiction over all cases arising under the constitution and the laws of the United States, and these courts, of course, have jurisdiction over all cases arising under the laws of the United States relating to inter-state commerce and the transportation of the mails.

Congress had, prior to the Debs riots, exercised the power thus given by passing various acts establishing the post-office system and providing for the transportation of the mails, and also regulating commerce among the States and prohibiting obstruction of it. Among other things it had declared the railroads involved in Debs's operations to be post roads for transporting the mails. To say that a disturbance at Chicago which stopped or delayed the transportation of mails between New York and San Francisco, and the transportation of passengers and merchandise between Minneapolis and New Orleans, was a disturbance purely "domestic" to Illinois is manifestly absurd. The persons engaged in it were violating *federal* statutes, and it was not only the right, but the duty, of the federal government to stop all violations of these statutes, and to use its own machinery for that purpose without waiting for the request or permission of the State authorities. As Chief Justice Marshall says, in delivering the opinion of the supreme court in an early case:

"*No trace is to be found in the constitution* of an intention to create a *dependence of the government of the Union on those of the States* for the execution of the great powers assigned to it. *Its means are adequate to its ends; and on those means alone was it expected to rely for the accomplishment of its ends.* To impose on it the necessity of resorting to means which it cannot control, which another government may furnish or withhold, would render its course precarious, the result of its measures uncertain, and create a dependence on other governments, which might disappoint its most important designs, and is incompatible with the language of the constitution."

The same considerations apply to the use of the federal courts as to the use of the federal troops for the purpose of suppressing disturbances involving violation of the federal statutes. I will only say, in passing, that, upon his own showing, Governor Altgeld has the same facilities under the constitution of Illinois for establishing a military despotism in that State that the president has under the United States constitution, according to the interpretation of it under which Mr. Cleveland acted, for doing the same thing in the whole country. The governor of Illinois has power in his discretion to order the State troops to any town upon the application of any one of half a dozen officers, and he could readily get such an application from some one of them if he desired it. It is merely a case of entrusting large powers to the discretion of an executive officer where some one must have the power to act promptly in an emergency.

The provision of the constitution to which Governor Altgeld refers as requiring the president to wait for an application from the State authorities is one entirely separate from those referred to, and has no bearing on the facts presented by the Chicago riots. It provides in substance (Art. IV, Sec. 4) that the United States shall protect each of the *States* against "domestic violence" upon application of the State authorities. The "domestic violence" here referred to is manifestly such violence as concerns only the inhabitants of the particular State by violating State laws only, and does not involve the rights of the people of other States. It is "violence" directed against the State in its "domestic" government. It is clear that the Chicago riots were not mere "domestic violence" in this sense.

Nor is there any merit in Governor Altgeld's argument in regard to the extraordinary nature of the means used for suppressing the riots. It seems, from what he and others have said on this subject, as if the writ of injunction were something new and unheard of, or, at any rate, that its application to such purposes was so extraordinary as to be entirely revolutionary in its character. As a matter of fact, the writ of injunction formed a part of the system of English jurisprudence for at least two hundred years before the colonies forming the United States separated from the mother country. It was borrowed by the English law from the Roman law, of which it formed a part some two thousand years ago, and it has been a part, and a necessary part, of the system of jurisprudence of every civilized country. Without it no adequate remedy could be supplied by the law for wrongs of a very serious nature. If my neighbor comes on my place and cuts down fruit trees or ornamental shade trees which it would take a generation or two to replace, or if a railroad company takes violent possession of my house which is endeared to me as a house by family associations and tears it down to make room for its tracks, it is no adequate compensation to me to have the offender fined and imprisoned or compelled to pay me a sum of money as damages. What I need for adequate protection is the *prevention* of such injuries, and not compensation for them. No more striking instance of this could be furnished than was furnished by the operations of Debs and his confederates. They were paralyzing the business affairs of millions of people, and it would be no adequate compensation to those injured to have Debs imprisoned or compelled to pay damages. What was imperatively needed was an immediate ending of Debs's unlawful operations, and this result could have been accomplished only by the action taken by the court, or by suppressing Debs and his confederates by military force.

It is to be observed, further, that the injunction is far more necessary as a part of the machinery of the courts for protecting the weak against the strong than for protecting the strong against the weak. Great corporations or rich men of great resources can usually protect themselves against unlawful interference with their property rights, but it is not so with the man of small means, and for him the summary interposition of the courts is essential when his rights are threatened. In this case the principal sufferers from Debs's operations were not the railway companies, but the multitudes of train men and others who desired to work on the railways, but were prevented by intimidation, and the other multitudes of workmen who were thrown out of employment by the shutting down of mills and factories for lack of transportation facilities.

Nor is it true that the use of the injunction in the manner in which it was used in the Debs case was at all extraordinary or unusual in any proper sense of those terms. The United States constitution provides (Art. III) that the judicial power of the United States shall be vested in the supreme court, and in inferior courts that congress may establish, and that "the judicial power shall extend to all cases in law *and equity* arising under the constitution, the laws of the United States," &c. Under this provision of the constitution, the United States courts have, from the foundation of the government, exercised the ordinary powers of the courts of equity to restrain by injunction interference with commerce between the States when conducted by water, and have granted and enforced injunctions prohibiting obstructions to rivers and other water-ways. While it is true that the courts have not until recently exercised these powers at all frequently with reference to transportation by railways, the application of this method of dealing with obstructions to inter-state railway traffic certainly forms no new departure. As the supreme court says in the Debs case:

"Constitutional provisions do not change, but their operation extends to new matters, as the modes of business and the habits of life of the people vary with each succeeding generation. The law of the common carrier is the same to-day as when transportation on land was by coach and wagon, and on water by canal-boat and sailing vessel; yet in its actual operation it touches and regulates transportation by modes then unknown,—the railroad train and the steamship. Just so is it with the grant to the national government of power over inter-state commerce. The constitution has not changed. The power is the same. But it operates to-day upon modes of inter-state commerce unknown to the fathers, and it will operate with equal force upon any new modes of such commerce which the future may develop."

Nor is there any merit in the objection that the method of dealing with Debs and his confederates takes away the right of trial by jury guaranteed by the constitution. The constitution does provide (Art.

III, Sec. 2) that "the trial of all *crimes* . . . shall be by jury"; but the offence for which Debs and his confederates were tried and punished was not a "crime" within the meaning of that term as used in the constitution,—that is to say, the violation of a penal statute,—but it was an entirely different offence, well recognized in the English system of law which prevailed in the mother country long before the separation of the colonies from it, and known as "contempt of court." The offence consisted, not in the violation of any penal law, but in disobedience of the court's orders, and it has been, from the earliest times, recognized as a necessary power of a court that it should have, of itself, the power to punish summarily all violations of its own orders. Without this power the court would be, in many cases, a mere mockery. Of what possible use would it be for a court to make an order directing a thing to be done, or prohibiting its being done, if the order could not be enforced? In most cases of this kind a jury trial would be a most inadequate means of enforcing such an order. This very case affords a striking instance of this. It was stated at the time, apparently on good authority, that Debs and his confederates had made elaborate preparations to furnish bail as soon as they were arrested anywhere on any charge, and to go on with their work of obstructing railway traffic, relying upon the slowness of the machinery of the criminal law to give them time to get such a foothold that they could defy the courts. It was only the summary interposition of the courts and the prompt use of the ample powers they possessed for enforcing their orders that enabled them to thwart this plan.

Nor is there any real ground for apprehension that any of the evils which Altgeld and his friends picture in lurid language as certain to come from confiding so great powers to the discretion of one man will really happen. It is not true, as they say, that it is a most extraordinary thing to give great powers in important matters to a single man; on the contrary, it is the most common thing possible in the ordinary affairs of civilized life. The officer in charge of a great steamer, when he sees another steamer approaching on the opposite course, has to decide whether he will go to port or starboard, and he must decide this himself and at once. There is no time to call a meeting of the board of directors or empanel a jury of the passengers to determine the question. If he acts in a critical moment from "whim, prejudice, or caprice," as Altgeld assumes that the judges will act, he may send both steamers to the bottom and destroy thousands of lives and millions of property. No locomotive engineer can make his daily run without having similar questions constantly presented for his immediate decision where a wrong decision is fraught with similar disastrous consequences, and even a switchman has similar responsibilities constantly thrust upon him. Most impressive proof of the fact that men having great powers over life and property do not, in fact, act from "whim, prejudice, or caprice," but are governed by fidelity to duty, is presented by the every-day occurrence of the safe arrival of an express train running, say, from New York to Chicago. We do not often stop to think of the vast multitudes of men engaged in the construction of the permanent way and the equipment, and in operating the road, any one of whom might, if he acted as Altgeld assumes that our judges do, wreck the train. Shall we have less confidence in the sense of duty of a picked body of highly-trained men like our judges than in track-layers and switchmen?

Precisely the same reason exists for giving judges great powers in granting injunctions, as in the case of the men I have referred to; somebody must decide at once, or the occasion for action will pass. To be of any service, an injunction must be issued and enforced at once, or the harm it is intended to prevent will be done.

But it may be objected that the officer in charge of a steamer and the locomotive engineer are not left to act on their own unfettered discretion, but are subject to rules regulating their action quite rigidly. Precisely the same thing is true of the judges; they are hedged in by long-established rules governing very minutely their actions in granting injunctions, and the violation of these rules renders them liable to impeachment.

There is another conservative force of a most potent character restraining judges in such matters. Professional men are peculiarly sensitive to the criticism of men of their own profession. The most unscrupulous and audacious judge would hesitate a good while before he would take any action which other judges and the members of the bar would consider illegal or even foolish. Professor Maine, in his work on "Ancient Law," gives a very striking instance of this. Under the Roman law the prætor, who corresponded to our chancellor or equity judge, was not controlled by any statutory law, but issued each year, when he took office, an edict or proclamation declaring the manner in which he intended to administer his court and the rules he intended to follow. Theoretically any new prætor might revolutionize the entire system of equity jurisprudence, but, as a matter of fact, each one adopted what his successor had done, with an occasional amendment, and the whole system remained singularly stable for some centuries. In explaining the causes of this remarkable result, Professor Maine, referring to the prætor, says:

"The checks on his apparent liberty are precisely those imposed on an English judge.

"Theoretically there seems to be hardly any limit to the powers of either of them, but practically the Roman prætor, no less than the English chancellor, was kept within the narrowest bounds by the prepossessions imbibed from early training, and by the strong restraints of professional opinion,—restraints of which the stringency can only be appreciated by those who have personally experienced them."

But perhaps the most conclusive answer to the fears expressed by Altgeld and other champions of liberty unfettered by injunctions is to be found in the experience of the civilized world as to what has actually happened on this point. It is to be observed that the arguments used relate to injunctions generally, and are not based upon anything peculiar to the granting of injunctions by the federal courts. Now, I venture to say that not a working day passes during which hundreds of injunctions are not issued and enforced by the various State and federal courts of this country, and not only is this true of the present time, but the same condition of affairs has existed since the foundation of the government. More than this, it exists, and has existed for a long time, in all civilized countries in the world. Yet, in spite of all this, none of the evils in regard to which so grave apprehensions are expressed have, in fact, followed. Neither this country or any other civilized country is, or ever has been, governed by the "whim, prejudice, or caprice" of judges by making improper use of their powers to grant and enforce injunctions. Nor is there any ground for apprehension that this state of affairs will be changed by any change in the character of our judges. The federal judges of this country are, and always have been, men of exceptionally high character and ability. As to integrity, learning, laborious care in their work, and fidelity to duty, they stand higher to-day than the judiciary of any other country, and I think no reasonable man can find any just cause for apprehension that they will abuse the great powers necessarily committed to them.

It may be pertinent to ask what other method the critics of the use of the injunction have to suggest for dealing with such difficulties as the Debs strike. As I have already shown, Debs and his associates were an obstruction to civilized life that had to be removed, and removed promptly. There are only two other methods than the one employed which suggest themselves to me for accomplishing this result. A counter mob might have been assembled to disperse the Debs mob, and this would certainly have been resorted to, if lawful methods of dealing with the difficulty had not been found; but it would clearly have been a reversion to barbarism. The other method consists in the use of military force. As the disturbance had gone far beyond the powers of the ordinary police force to deal with it, it would have been necessary to use either State or federal troops (and for the purposes of the present point it makes no difference which) to disperse the mob organized by Debs, and, in view of the extreme bitterness with which the contest was conducted by Debs and his confederates, it is quite apparent, in the light of our experience in such matters, that the troops would sooner or later have been compelled to fire into the mobs. This certainly is not a method which ought to be resorted to, unless all other lawful methods fail. In this connection I observe that Altgeld complains with much bitterness that some four hundred men, besides Debs and his immediate associates, were arrested for disobedience of the court's orders, and were afterward discharged because nothing could be proved against them, and that some of these men were taken a considerable distance away from their homes for trial and were so poor that they had to walk home and beg their way. While this does seem to involve hardship, yet the hardship was clearly not so great as if these same men had been killed by shots fired into the crowds by troops. The *rôle* of an innocent spectator of mob violence is always a hazardous one, but the hazard is certainly not as great when injunctions are used to disperse the mob as when bullets are used for that purpose.

I think men of plain common sense will have no difficulty in agreeing with the supreme court, when it says in the Debs case:

"Indeed, it is more to the praise than to the blame of the government that, instead of determining for itself questions of right and wrong on the part of these petitioners and their associates, and endorsing that determination by the club of the policeman and the bayonet of the soldier, it submitted all those questions to the peaceful determination of judicial tribunals, and invoked their consideration and judgment as to the measure of its rights and powers and the correlative obligations of those against whom it made complaint. And it is equally to the credit of the latter that the judgment of those tribunals was by the great body of them respected, and the troubles which threatened so much disaster terminated."

It is true, as Altgeld says, that the power to issue injunctions has been abused; but this is true of all powers confided to officers of the government, or to any one else, and the abuse of the power to issue injunctions has, under all the circumstances, been extremely small. The courts did, in this very class of cases, go too far at one time by forbidding men operating railways in the hands of receivers appointed by the courts to quit work; but this was immediately corrected, and in the Debs case, at any rate, no such question arose, the supreme court saying in its opinion that "the right of any laborer, or any number of laborers, to quit work was not challenged."

There is also some force in the objection to what are called "blanket injunctions,"—that is to say, injunctions addressed generally to large numbers or classes of men whose names are not given,—but it is not true, as is asserted, that there is anything new or extraordinary in this. On the contrary, it has for a long time been customary, in cases of conspiracy like the Debs case, to include in the injunction all the confederates of the principal parties named, without naming such confederates. It is a form of injunction, however, liable to abuse when applied to cases of this kind, and which should be resorted to only in great emergencies. I think the federal judges can be relied on to restrict its use within proper limits.

It is not considered by the managers of a railway a valid objection to the equipment of passenger-cars with quick-action brakes that a foolish engineer may make improper use of them by making an emergency-stop every time a dog crosses the track in front of him, and shaking up the passengers unnecessarily. Railway managers are practical men, and they get the best modern equipment for their roads, for use in emergencies as well as under ordinary conditions, and rely on their men to use it properly. The same principle applies to the government. We want our government provided with the best possible modern equipment for maintaining law and order in emergencies as well as in ordinary affairs, and we can rely on our judges to use it properly.

No one has a deeper interest in this than the wage-earner, because he, more than any other man, depends for his prosperity upon the absolute and continuous maintenance of peace and good order. His labor, which is the only thing he has to sell, is the most perishable of commodities. If the owner of a bushel of wheat or a yard of cloth does not sell it to-day, he can keep it for sale to-morrow, but it is not so with the wage-earner. If the labor of to-day is not done and is not disposed of for the wages of to-day, its value for the wage-earner disappears utterly and is lost. To-morrow is another day, and its labor brings other wages.

The direct loss caused by the Debs strike to the wage-earners of the country, even as it was, reached millions of dollars, but this was a mere bagatelle compared with what the wage-earners would have lost, if the disturbance had not been promptly suppressed.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

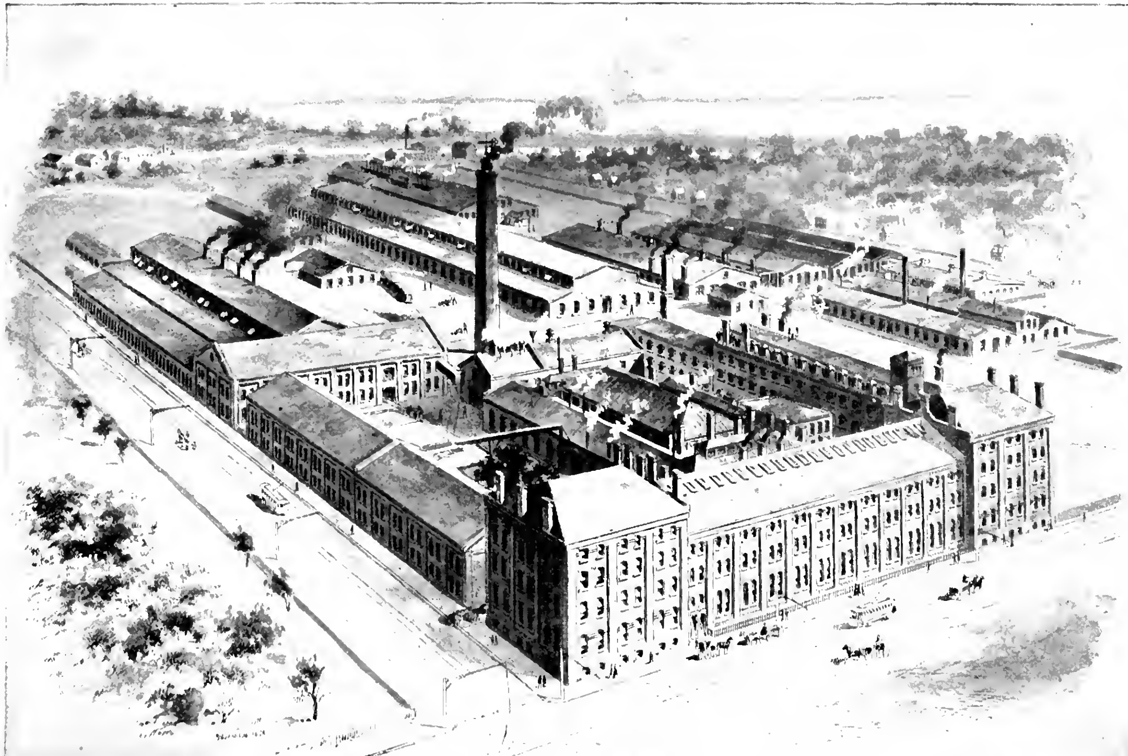
By Henry Roland.

III.

THE dealings of the Whitin Iron Works and the Cheney Silk Mills with labor are marked by an absence of fixed method and a general policy of individual treatment in which special hardships are alleviated by the special means that may seem best fitted to the case.

The Yale & Towne Manufacturing Company reaches success by the opposite course of precise law and rule, framed with infinite labor and minuteness of detail to cover every case which can possibly arise. These laws, rules, and regulations may, I think, be justly said to be wholly the work of Mr. Henry R. Towne, the president of the company, and I think, also, that it is true that his personal attention has been so minutely directed to every detail of the manufacturing operations of his concern, and that, joined to this, his executive ability is so commanding that his own conception of what is correct governs every movement of the workmen in their working-hours, and that the success of the enterprise which, under the name of the Yale Lock Company, started under his sole management in 1868 with less than thirty hands, and having now a pay-roll of about 1,400 names, may be said to belong to him personally and individually. It is, of course, true that he has been ably and indispensably assisted by those in responsible positions under him, and that the foundation of the business was and remains the improvement in the art of lock making embodied in the inventions of Linus Yale, Jr., who died in December 1868. Yet the business in all its details has been so thoroughly permeated by Mr. Towne's everywhere-present personality, that the success of the company may be truly said to be wholly his creation.

Linus Yale, Sr., who was an inventor and mechanic of general merit and wide ability, employed some twelve or fifteen men at making pin-tumbler bank and safe locks at Newport, Herkimer Co., New York, and his son, Linus Yale, Jr., had just established a factory for the production of locks of the same character at Shelburne Falls, Mass. Linus Yale, Jr., had a strong leaning towards art, and began as a painter. He was familiar with the work in his father's shop, and the absorbing fascination of the endless problem of the lock soon caused him to abandon the easel for the work-bench. His first venture in business



FACTORY OF THE YALE & TOWNE MANUFACTURING CO.

THE TOOL ROOM.

for himself was in Philadelphia, but he soon removed to Shelburne Falls, where he employed about fifty men in 1866 on high grade pin-tumbler and bank locks and his "double treasury" lock. This "double treasury" lock was a very peculiar construction, weighing about 62 pounds, selling for $450. and having a key with separable bitts which, in the process of unlocking, left the key shank, travelled a considerable distance away from it, arranged the tumblers in unlocking position, and finally returned to the key shank and reunited themselves with it, as the bolt was withdrawn. In 1868 the Shelburne Falls establishment had thirty or forty hands, and two sons of Linus Yale, Jr., were in the shop. It was at this time that Mr. Yale and Mr. Towne entered into business relations. Mr. Towne had had a thorough engineering training: his father had been associated with I. P. Morris in the Southwark Foundry, Philadelphia, and Henry R., at that time only twenty-four or twenty-five years of age, had been through the shops, was a skilful and thorough draughtsman, and had received a general scientific education. Mr. Yale had made a great advance in the theory of lock-making by separating the parts of a lock according to the office filled by each, grouping the tumbler mechanism in a "cylinder" forming a distinct part or structure, and the bolt and case in another, and had greatly reduced the size, thickness, and weight of the key for operating the "Egyptian," or pin-tumbler, lock. This pin-tumbler lock is one of the oldest known, but in its earlier forms had a cumbersome key, and, although familiar to the early German and English lockmakers, had never been recognized as holding commanding possibilities. European lock-makers relied upon warded locks up to Barron's invention of the lever tumbler; the warded locks had large and elaborate keys; the Barron tumbler made a much smaller key possible; and later still Bramah invented the sliding radial tumbler, which had a very small, light, cylindrical key, and gained great favor. A little later Chubb rivaled Bramah with a new improvement in lever tumbler-locks, and Bramah and Chubb in Europe, and Yale, Sr., with his modification of the Egyptian lock, in America, represented the leading advances in the art of lock-making at the time Yale, Jr., came upon the field, and, by making a small, thin, flat key suitable to control the movements of the pin-tumblers of the ancient Egyptian locks, laid the foundation for a new line of manufacture, which so favorably impressed young Towne that he resolved to identify himself with its development. A partnership was formed in October, 1868. Stamford, Conn., thirty miles east of New York, was selected as a suitable location, and Mr. Towne at once began the planning and erection of the new factory. In December, 1868, Mr. Yale, who was still carry-

A MODEL MAKER AT WORK.

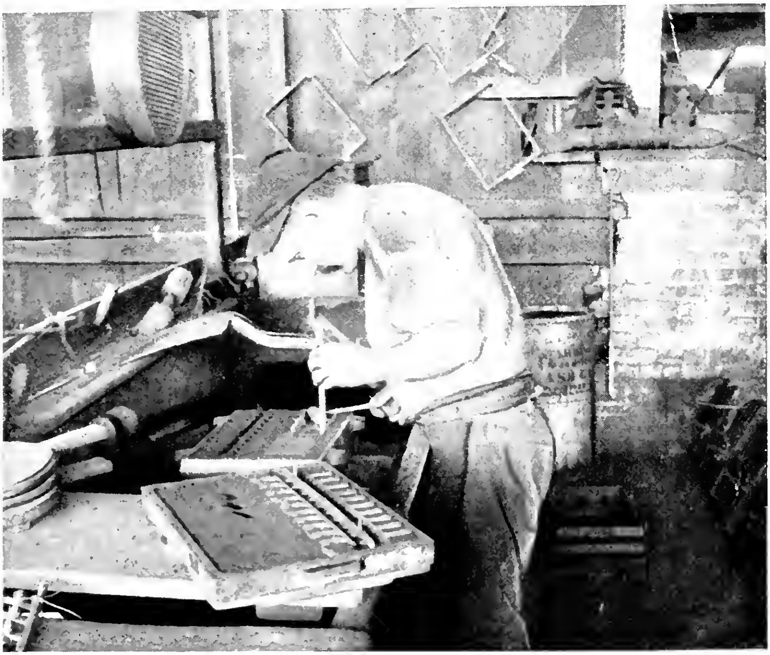
METAL PATTERN MAKING.

ing on the Shelburne Falls business, died suddenly of heart disease at a New York hotel; Mr. Towne proceeded with the shop at Stamford, and in March, 1869, with the assistance of John B. Yale, son of Linus, Jr., the Shelburne Falls plant was removed to Stamford, and the new shop was put into operation with about thirty hands. In June, 1869, the company was incorporated with $150,000 capital, and Mr. Towne chosen president; in 1870 the entire Yale interest was acquired by Mr. Towne; in 1881 the capital was increased to $500,000, and again in 1883 to $1,000,000, at which the share capital still stands, although the invested capital is more than twice that amount.

When the Stamford works began operations in 1868-9, wages in America were at their highest point, although gold had fallen considerably from its highest premium. Tool-makers' pay was $3.00 to $4.00; moulders', $3.00; lock-makers', $2.25; boys', $1.00 to $1.25 per day. These high rates could not possibly continue; they were due directly to the depreciated currency values incidental to the suspension of specie payment during the war of the rebellion, and consequently demanded readjustment as the value of greenbacks appreciated. From the first the tool-makers had formed the only large class of day-pay

IRON MOULDING WITH MACHINE.

workers. Tool-making in the Stamford shops has always been carried to the utmost limit of economy, and the force of tool-makers has consequently been very large. The moulders were, from the first, individual piece-workmen, and production of work for sale was effected by the contract system, New England style, the contractors hiring and discharging their own men, and receiving a fixed piece-price for finished work. The workmen made their day-pay, no more and no less, except sub-contractors, who undertook portions of a principal contractor's work and supervised the labor of a limited number of hands. The principal contractors made from $2,000 to $4,000 yearly, which is, or was (as the contract system is disappearing), about the usual New England rate of contractor's earnings. The contractor's pay depended entirely on his ability to get work out of men. If a contractor could furnish brains and energy to sixty or seventy men, so that each one should do his work in the most intelligent manner and shortest space of time, he could, of course, make better pay than a less capable contractor, who could manage only, say, ten or fifteen hands. It is still an open question whether or not the contract system produces the cheapest and best work, and this question will probably not be soon determined, as the contract system is in disfavor, and is being gradu-



BRONZE-MOULDING BY HAND.

ally, but constantly, discontinued. In one case within my own knowledge a very able contractor who "runs" from sixty to ninety men divides his gains in excess of $5,000 yearly evenly with the management. In most cases the effort now is to replace the contractor by fixed-pay foremen, and to put the hands on piece-rate pay, thus exactly reversing the former method of paying the hands by the day and the contractor by the piece.

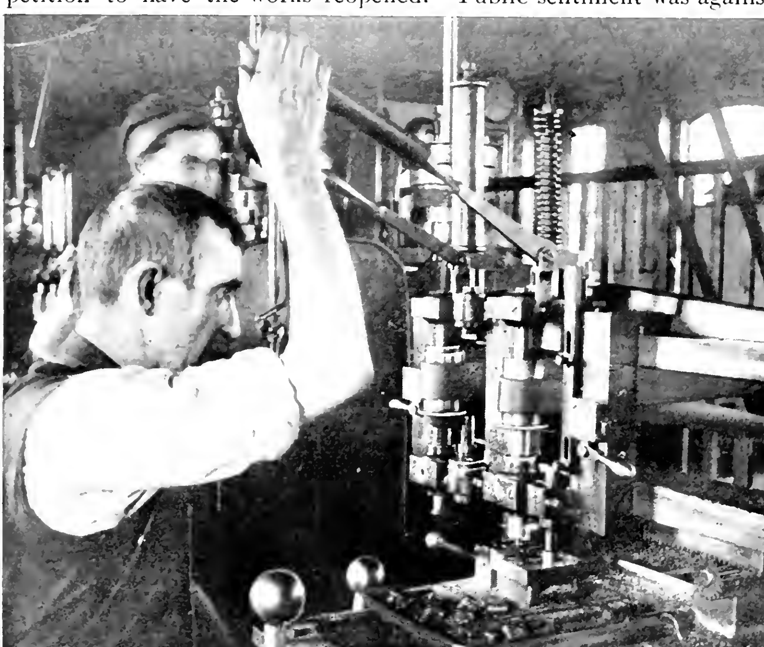
In spite of the constant fall in the prices of all other commodities, the first avowed cut in wages was made in the Yale & Towne shops in 1876, eight years after starting. This cut took the form of a flat reduction of fifteen per cent. on all fixed-rate pay in the establishment; it was made at a time when the shop was short-handed, having only about one hundred and seventy-five men at work on short time. This cut was fully recognized by the workmen as just and necessary, and was accepted without remonstrance. Another reduction of ten per cent. was made in August, 1893; the shop was running full-handed and on full time, but, in spite of these evidences of shop prosperity, the hands believed the reduction justified, and again accepted the cut without question. In fact, there has never been any money trouble between the management and the workmen at the Yale & Towne

IN THE CORE ROOM.

shops, though the rates for piece work have been steadily reduced from the day the shop started until now.

The only real trouble with hands began through the determination of one moulder to wash up in his own bucket, on his own floor. From the very first Mr. Towne's management has included extreme neatness as a prominent feature. The yards inside the works are perfectly clean, not a dead leaf or a scrap of paper being allowed to lie on the ground. Lavatories are abundant through the shops, and are in many cases in the form of individual wash-bowls, and the use of the well-appointed washing facilities is not optional with hands, but obligatory. Fine brass castings, or, rather, the very finest of brass castings, are absolutely essential to the economical production of the Yale & Towne manufactures, and, as a consequence, the establishment has a force of extremely skilful brass moulders, who are, of course, fully aware of their own importance and value. It had been the custom of the moulders to wash up in buckets, every man in his own place. The management provided an elevated lavatory with washing-troughs, suspended from the roof, reached by stairways, and bringing a man's head about twenty feet above the floor when he stood at the washing-troughs. Pouring is continuous, from 9 A. M., in the brass foundry, and the atmosphere twenty feet above the floor is always unpleasant, especially in warm weather. The moulders are allowed ten minutes for washing up, which is their own time, as they are individual pieceworkers. On June 28, 1890, one of the moulders began to wash up in his own bucket on his own floor at 5.50 P. M., as he preferred this to the lavatory conditions. The foreman remonstrated; the workman was obdurate; the foreman told the workman to take his "blue ticket" (full-time pay and discharge) to the office; and the workman said he would do so, and, having thus become an independent citizen, he delivered a very frank opinion to his former superior officer, and left the place, to all appearance in peace.

Next morning, however, the twenty-eight remaining moulders struck against the lavatory. This was serious, as the moulders could not be easily replaced. The best help that could be obtained was hired in, and, as there had been threats made, was guarded and lodged on the premises. The strikers organized, and had a "labor delegate" up from New York to confer with the management, without effect. The brass castings were poor, and on July 15 the entire plant was shut down. About August 15 a deputation of the chain-makers sent in a petition to have the works reopened. Public sentiment was against



FINISHING PADLOCK CASES IN EDGING MACHINE.

the moulders, who fell immediately into line with the chain-makers, and the works were reopened, each man filling up and signing the following application and contract, which the management esteems perfectly fair and impartial, and under which every hand in the Yale & Towne Factory is now employed.

7360-10 95-10

THE YALE & TOWNE MANUFACTURING COMPANY

APPLICATION FOR EMPLOYMENT.

The undersigned hereby makes application for employment in the Works of THE YALE & TOWNE MFG. Co., and submits the following statement of facts:

Name, ____________________

Where born, ____________________ *Age,* ____________

Address, ____________________

Occupation, ____________________

Last employed by ____________________

Address, ____________________

From ____________ *189* , *to* ____________ *189*

Previously employed by ____________________

Address ____________________

From ____________ *189* *to* ____________ *189*

Do you belong to any organization or association which would prevent your honorably carrying out the terms of the within contract? ____________

If so, what is its legal title? ____________________

**Do you agree not to join any organization or association which would prevent your honorably carrying out the terms of the within contract?* ____________

Married or single? ____________ *Family* ____________

This is a True Statement.

* These questions are simply for the information of the Company and are not intended to curtail the right of the applicant to belong, now or later to any reputable organization.

____

In the presence of

____

Labor and Capital are Co-Partners; neither can prosper without the other; the injury of one should be the concern of both.

CONTRACT

BETWEEN

THE YALE & TOWNE MFG. COMPANY,

AND

THE YALE & TOWNE MANUFACTURING COMPANY, as one of the parties of this contract, hereby agrees with other party hereto as follows:

(1.) To punctually pay all wages or other earnings.

(2.) To have due regard for the rights and the reasonable convenience of employees.

(3.) To exercise reasonable care for the health and comfort of employees in all sanitary arrangements.

(4.) To give due consideration and prompt reply to requests, properly presented by employees, relating to matters which affect their welfare, and which are within the Company's control.

(5.) To fairly adjust with each employee, individually, the wages or other compensation, and to review this adjustment at reasonable intervals, if so requested.

(6.) To give a certificate of honorable discharge, if so requested, to any employee entitled to it who has been not less than six months in the Company's service.

THE YALE & TOWNE MFG. COMPANY.

By

PAYMASTER.

IN CONSIDERATION OF employment by THE YALE & TOWNE MANUFACTURING COMPANY, and the covenants on the part of the latter herein set forth the person above-named hereby agrees with said Company as follows:

(7.) To faithfully render the service which is undertaken and for which the Company pays.

(8.) To conform to the shop rules and carry out instructions received from the Foreman or the Officers of the Company.

*(9.) In case any reasonable ground for complaint exists, to report the facts, first to the Foreman, and if no redress is thus obtained, to bring the matter, preferably in writing, to the notice of the Company, through the Paymaster or one of its Officers.

*(10.) To take no action of any kind, individually, or with others, tending to cause disturbance of the relations between the Company and its employees, because of any grievance, until the matter has been first submitted to the Company in the manner indicated in Article 9, and, if said request, so presented, is not granted, to take no action tending to harass or injure the Company until at least fifteen days shall have elapsed after such request has been presented to the Company without its taking action thereon.

(11.) To withdraw and abstain, during the period of this contract, from membership in any organization whose rules would prevent the honorable carrying out of this contract.

(12.) To forfeit to the Company, as liquidated damages, a penalty or fine equal in amount to one week's wages or earnings, in event of any violation of Articles 10 or 11 of this contract.

*In Departments A and B, complaints under Articles 9 and 10 are to be made in the first instance to the Foreman or Contractor; if not acted on within three days, then to the Dept. Superintendent; if not acted on by him within three additional days, then to the Company as per Article 9.

STAMFORD, CONN., 189

RIGHTS.

The following rights are to be mutually recognized and respected by each of the parties to this contract, the Company acting through its Superintendents, Foremen, Contractors or other authorized agents

(1.) The right of the Company to employ whom it desires.

(2.) The right of the Company to discharge without notice any Employee violating its rules or the terms of this contract.

(3.) The right of the Company to discharge any Employee whose services are not satisfactory, or not needed.

(4.) The right of the Company to decline giving employment to members of organizations whose management or policy the Company believes to be antagonistic to its interests.

(5.) The right of the Company to discharge any Employee found guilty of misstatement of facts in this application for employment.

(6.) The right of each Employee to negotiate concerning the rate of compensation in any manner not inconsistent with the foregoing contract.

(7.) The right of each Employee to request, in the manner therein indicated, action by the Company on any matter affecting the welfare of the Employee.

(8.) The right of each Employee to have access to the officers of the Company for the statement of any grievance, action on which has been refused or neglected by the Foreman.

(9.) The right of each Employee to belong to any society and to attend any meetings, provided that in so doing none of his agreements with the Company, as herein set forth. are violated.

(10.) The right of each Employee to withdraw, at pleasure, after reasonable notice, from the Company's service.

EMPLOYMENT MEMORANDUM

_______________189

To the PAYMASTER:

____

The applicant named herein, begins work this day, in

*Department*__________, *as a*__________

He was / *He was not* } *formerly employed by this Company in Dept.*______

*Entered*__________*o'clock.* __________
Foreman.

*Check No.*__________

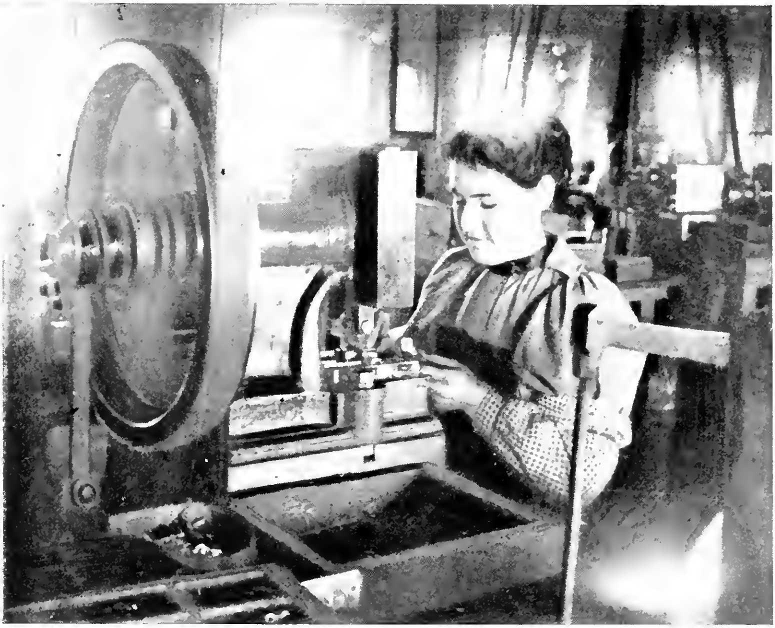
I hereby certify that I know of no reason why the above applicant should not again be employed in the Company's Works.

____

CUTTING KEYS.

This document is given in full, as its use has secured nearly six years of unvarying amity at the Yale & Towne works. When carefully considered, this paper seems really fair to the workmen in every particular, and, fair or unfair, it has the mint-stamp of successful practice, and hence is worthy of the most respectful consideration.

In 1887 a profit-sharing system was devised to take the place of the contract method. This profit-sharing scheme was based on what the management considered a liberal piece-price for producing the finished work ; this was an arbitrary assumption, based, of course, on a long series of records of the previous cost of the same or similar wares, and this piece-price so fixed on work delivered constituted the department's credit. Against this credit the labor cost, files, waste and oil, and small tools' and special tools' maintenance were charged ; if the charges footing was less than the credit footing,—as it was, I believe, in all cases,—the difference was credited to the department as profit gained, and one-half was divided among all workers in that department in a flat percentage on wages earned, the company taking the other half. These contracts were made for from three to five years without variation in piece-rates ; the foremen were paid at day-



PIERCING THE KEY BOWS.

rates from $4 to $6, and the workmen were paid sometimes day-rates and sometimes piece rates. The highest gain was as much as thirty per cent. of wages, which gave every man, foreman and workman alike, a 15 per cent. addition to his wages at the end of a year. In case of a foreman who had been a contractor and had made $3,000 a year, and who was, under the profit-sharing system, rated at $5 per day, or, say, $1,500 a year, the 15 per cent. gain would give him $1,725 for his year's pay, instead of, say, $3,000, which he might have made under the contract system. Common hands, making, say $500, would have $75 added, making their total pay $575. The faults of this system are the long periods between divisions of gain, and the small incentive to close application on the part of the foremen. It was abandoned as a general policy in 1893, although profit-sharing was continued in one case up to August, 1895.

The method now in use for reducing cost is to divide the whole force of workmen into small groups, in no case embracing all the occupants of any one room, and, by careful observation of the operations of each group, decide upon possible reductions in piece-prices paid to workmen without lowering their total earnings beyond possible recoupment by the use of improved means of production, or by increased diligence on the part of the workmen themselves. The foremen are paid by the day, the workmen by the piece. Change is made in the price paid to only a single group at one time; it is the intention to adjust prices once a year: by using the whole year's time, and hence affecting very few workers at once, this method of reducing piece-prices is followed without difficulty. It probably could not be followed without a new force of hands each year, if the reductions were made on the same day throughout the entire establishment.

About one hundred girls are employed, whose pay runs from 75 cents to $1.25 per day. The pay of moulders and tool-makers is from $2.25 to $3.00 per day, the moulders on piece-work; lock-makers, $1.50 to $2.00; boys, from 75 cents up. Just now (October, 1896) the establishment is short-handed and on short time, though it has been generally the case that hands who wished to do so could put in three thousand hours of work in a year.

The marked features of the Yale & Towne management to-day are extreme neatness of premises, great attention to really artistic designs of ornament, lavish tool-making in every department, and, last and

SETTING UP THE YALE LOCK.

most important and individualizing of all, the perpetual and everywhere present personal influence of the presiding officer.

Mr. Towne is conscious of the rectitude of his intentions, and intends in all cases fully and fairly to consider the best interests of all parties affected by any proposed course of action connected with the shop management; he believes that, if the situation is clearly and minutely explained to the workmen, they will in all cases approve his decisions, and the management will consequently have the hearty coöperation of the hands in carrying proposed changes to a successful issue. Hence a constant succession of notices and bulletins posted through the shops, of which two are given as sufficient examples, although others, even more unusual in form, were in evidence.

WORKSHOP LAVATORY.

NOTICE

To Superintendents & Foremen.

Subject: Disposition of Scrap Metal.

In order to obtain better prices for our scrap, it is necessary that, as far as possible, all steel and iron scrap shall be kept separated one from the other, and turnings not mixed with scrap consisting of solid material.

To reduce general expenses of handling scrap, arrangements have been made by which two of the yard-men will pass through the different departments every other day and collect all scrap therein, transporting it to places provided for it. This only applies to miscellaneous small steel and iron scrap. Departments P and T will dispose of the main body of their scrap, as heretofore. This refers particularly to skeleton steel and brass scrap produced by P, and the iron and steel turnings produced by D and T. In these cases the above-mentioned departments will have their scrap wheeled to places designated.

We trust that with the coöperation of the superintendents and foremen of the different departments and rooms, we may reduce the expense of handling this material to the lowest limit.

THE YALE & TOWNE MFG. COMPANY.

February 25, 1896.

NOTICE

To Superintendents & Foremen.

The expense account for electric light, gas, and water for the year 1895 has been greatly in excess of the expenditures for previous years.

As this amount represents about one-sixth of the total running expenses for heat, light, and power, it is quite necessary that it should be reduced to a minimum. You are requested, therefore, to use extraordinary care and diligence in the use of gas, electric light, and water in your respective departments and rooms therein. Especial attention should be given to the use of lights Saturday nights between the hours of 5 and 6. Persons delegated to clean machinery should be cautioned to put out all lights not actually needed. In cases where there is running-water in the rooms, either for cleaning, plating, or manufacturing purposes, extra care should be exercised in the quantity used, and pains should be taken to see that the faucets are closed when the water is not actually needed.

By exercising due care in following the above suggestions, the departments will not only coöperate in the reduction of running expenses to the company, but also reduce the amount chargeable to their respective departments.

THE YALE & TOWNE MFG. COMPANY,
F. A. Waldron,
Supt. Power and Plant.

Dated, Feb. 21, 1896.

The Yale & Towne Company owns no tenement property. Deposits may be made by the hands with the company at four per cent. interest, compounded annually.

The workmen have a mutual benefit association, managed exclusively by officers of their own choice. Full members pay monthly dues of 50 cents, and may draw $5 per week for twenty-six weeks in any one year, if prevented from work by sickness; $100 is paid in case of death. Medical advice is furnished free, and a twenty per cent. rebate on prescriptions is given. Junior dues and benefits are half the above. Monthly dues are remitted when there is $1,800 in the treasury; the average is about ten monthly payments in the year. This association also gives one day's summer outing to its members, and one winter evening assembly.

There was a very elaborate scheme in practice for a time for encouraging the workmen to make inventions and improvements in shop-processes. The last payments under this scheme were made some two years since, and this unique plan may be considered as among the things of the past, not needing to be specifically detailed here.

It will be observed that the dominant feature in the prevailing system of labor employment in the shops of the Yale & Towne Manufacturing Company is individual piecework, wherever applicable, in other words, the employment of self-interest as the chief and best stimulant to keener intelligence and greater exertion in the performance of work. In all cases piece-rates are so adjusted as to enable competent workmen to make earnings at least equal to, and usually better than, their earnings when working by the day. Moreover, piece-rates, when once established, are maintained without change for a period of at least twelve months, this fact being announced in advance and employees encouraged to make as high earnings as possible during the period. When facts appear to justify it, piece-rates are reduced, but never below the point at which a competent workman can make more than his day-rate. The fairness of this system is obvious, and during the many years since its adoption no difficulties have arisen as to piece-rates between the company and its employees.

Perhaps, however, the most striking characteristic of the management is its centralized character,—the well-defined relationship of each subordinate to the next in authority, and the final centering of all of these under a single executive head. This system has been so perfected as to enable the president, by means of regular and frequent reports, both written and oral, from the various heads of departments, to keep in close touch and sympathy with all, to co-ordinate and harmonize the operations at every point, and to exercise an effective direction of operations in every department.

HIGH-SPEED STANDARDS OF MEN, MACHINERY, AND TRACK.

By H. G. Prout.

SPEED, being first a question of power, must affect the size and weight of the engine. In turn the weight of the engine and the speed at which it is driven affect track and bridges. But speed depends upon ability to keep going after you start, and this is largely a matter of signals and all the machinery of protection. Furthermore, speed from terminus to terminus is a question of economy of the seconds consumed in stopping, and this concerns the efficiency of the staff,—in other words, administration and discipline.

As locomotive wheel-weights set a limit below which permanent way cannot go, we may begin our consideration of the relations of high speed to men and material by inquiring somewhat into changes that have been made in recent times in the weights carried on locomotive drivers.

In 1880 the highest type of fast passenger locomotive on the Pennsylvania Railroad was the class K engine, which carried 59,000 pounds on four drivers, or 14,750 pounds on each driver. The drivers were 78 inches in diameter and the cylinders 18 × 24 inches. The boiler was 49½ inches in diameter. This engine had developed in 1894 into the revised class P, carrying 21,800 pounds on each driver, the drivers being 80 inches in diameter. The cylinders were 19 × 24 inches, and the boiler 57⅞ inches. To-day the class L is the highest standard of the Pennsylvania. This engine has 22,900 pounds on each driver. The cylinders are 18½ × 26 inches and the diameter of the drivers 80 inches.

On the New York Central Mr. Buchanan had brought out in 1877 his standard 8-wheeler. These engines carried 44,800 pounds on the drivers, or 11,200 pounds on each. The cylinders were 17 × 24 inches, the drivers 68½ inches in diameter, and the boiler 47¼. About 1892 the 800 class was brought out, of which the well-known No. 870 was the pioneer. This locomotive has cylinders 19 × 24 inches, and carries 81,400 pounds on the drivers, or 20,350 pounds on each. The drivers are 78 inches in diameter and the boiler 58 inches. A little modification brought out a year later the New York Central's class N, of which No. 999 is the most famous individual. The drivers of this class are 86 inches, and they carry 21,000 pounds on each. All of these later locomotives, the Pennsylvania class L, and the New York

Central 800 class and class N, are running in regular service, and are no longer looked upon as exceptions.

But such dimensions and wheel-weights are not confined to these two roads. Within the last two or three years there have appeared, among other big locomotives designed for fast passenger work, the Delaware & Hudson Company's 19 × 24-inch engines, with 68½-inch drivers carrying 21,000 pounds on each driver; the Chicago & North Western's recent 8-wheelers with 19 × 24-inch cylinders and 75-inch drivers carrying 19,500 pounds on each driver; the Lehigh Valley's wide-firebox 8-wheelers with 19 × 26-inch cylinders, 76-inch drivers, and 81,800 pounds on the drivers, or 20,450 pounds on each; the Chicago, Burlington & Quincy's Columbia type with 19 × 26-inch cylinders, 84¼-inch drivers, and 21,550 pounds on each driver; the New York, New Haven & Hartford's latest 8-wheeler with 20 × 24-inch cylinders, 73-inch drivers, and 23,000 pounds on each driver; the Rock Island's class 22-A with 78-inch drivers carrying 20,750 pounds on each, and 19½ × 26-inch cylinders. It must not be understood that I have attempted to mention all of the heaviest recent passenger engines,—only enough examples to show the weight now concentrated on a driver.

All of these engines have four-coupled drivers. These do not, however, express the maximum wheel-weights now in use. The Philadelphia & Reading has in service two recent locomotives lighter than the 8-wheelers which we have mentioned, but carrying more on the drivers. These are single-driver engines,—that is, with one pair of drivers. The driving wheels are 84½ inches in diameter, and each one carries 24,000 pounds. The cylinders (compound) are 13 and 22 × 26 inches. It is not at all improbable that this type will come into larger use in this country as the conditions under which it is most efficient are developed,—that is, as the demand grows for a class of rather light but very fast trains not making many stops. It is supposable that such conditions will be developed in this country with increase of population, as they exist to-day in England.

Simultaneously with this development of the locomotive has gone on an improvement of track. It would be absurd to claim that this has been the consequence solely, or even chiefly, of the increase in speed of trains. The greater part of the revenues of the railroads of the United States comes from freight traffic. Out of the total traffic earnings of $1,075,000,000 in 1895 the earnings from freight were $730,000,000, or 68 per cent. of the total. The freight train-miles run in the year were 38 per cent. more than the passenger train-miles. The weight of freight trains, and consequently the weight of freight locomotives, has increased even more than the weights in the passenger service. What part of the cost of maintenance of way is due to freight and what should be assigned to passenger traffic no one can possibly determine. The interstate commerce commission has at last abandoned the attempt, persisted in for a number of years, to distribute maintenance of way expenses between freight and passenger business. The chief object in increasing the weight of rails and in making track more stable is to save maintenance expenses.

It follows that heavier freight locomotives, heavier and faster freight trains, and increased freight-train mileage must all have had much to do with improvement in the track in the last ten or twenty years. Still the growth in passenger-train speeds has had a great influence in bringing about the improvements designed, not only to decrease maintenance expenses, but to add to the safety of working fast traffic.

One of the first improvements to be observed, and the only one for which we can really give figures, is in the weight of rail. I have tried to get some measure of this increase, and to that end have consulted rail makers.

The Lackawanna Iron & Steel Co., in 1891, rolled no rails over 80 pounds to the yard. In 1895 nearly 21 per cent. of their product was from 85 to 100 pounds per yard and nearly 12 per cent. was 100 pounds. In 1891, 28 per cent. was 80 pounds and in 1895, 30 per cent. was of that weight ; 50¾ per cent. was from 72 to 80 pounds in 1891, and in 1895 those weights made up 52.7 per cent. of the total product. In 1891, 17.24 per cent. of the product of these mills was 56 and 60-pound rails ; in 1895 these weights were but 1.69 per cent. of the total. The heaviest rails rolled by the Bethlehem Iron Co., in 1874 were 65 pounds to the yard ; in 1884 their heaviest rail was 76 pounds ; in 1893 it was 100 pounds. The *average* weight of rails rolled by the Illinois Steel Co. in 1889 was 63.5 pounds per yard ; in 1895 it was 71.08. This average rose steadily year by year in that period of seven years. The Pennsylvania Steel Co. reports that 56-pound rails seem to have been discarded by railroads in the east from main line standards, and that roads of heavy traffic are going up to 85, 90, and 100 pounds, the recent tendency being to 100 pounds. These reports show the rate of the movement towards heavier rails with considerable accuracy.

If we take up individual roads, we see the same tendency. The New York Central, for example, adopted 80 pounds in 1883, increasing the weight at one step by 15 pounds. Recently that road has put in considerable rail as heavy as 100 pounds to the yard. The Pennsylvania Railroad adopted an 85-pound rail in 1888, and now it has gone up to 100 pounds as standard for main line of heaviest traffic. In 1889 the Michigan Cenral adopted an 80-pound rail as standard, and in 1888 the Philadelphia & Reading put down a 90-pound rail on its line of heavy fast traffic between Bound Brook and Philadelphia. In 1890 a 95-pound rail was designed for the Boston & Albany, and that is now the standard weight of that road. I have mentioned the pioneers, but do not pretend to have named all the railroads that have adopted standards of 80 pounds or more.

It seems worth while to mention one exceptional case. The Manhattan Elevated in New York uses very light engines, and its maximum speeds are not high; but it is one of the very few railroads in the United States that have a 90-pound rail. Here the intensity of the traffic and the difficulty and cost of renewing rails introduce special conditions.

The improvements in recent years in ballast, in drainage, in ties, and in all the elements that go to make up permanent way cannot be measured by any figures, even approximately correct. We can only say "from information and belief" that they are no less striking than the growth in the weight of rail. Perhaps the increase in weight of railroad bridges, made necessary by the greater weight of recent locomotives, is even more important than the increase in stability of permanent way. In short-span bridges especially the change in practice in the last ten years has been very remarkable. Plate girders have taken the place of pony trusses; trussed spans have been made heavier; and solid, ballasted floors now find many advocates among bridge engineers.

But, when we are considering the past experience and the future effects of very high speeds on material and methods, we must not forget the question of stopping. This is perhaps the most important of all, and certainly one of the most difficult to deal with. That you may stop in time two things are necessary,—the machinery that tells you to stop and the machinery to stop with—signals and brakes. Perhaps few people have any conception of the speeds that are reached in daily practice. All over the country trains are run at over 60 miles an hour every day, and must do that to make their time between terminals. There are trains that get up to a speed of 75 miles an hour for short distances in their regular daily runs, and 80 or 85 miles is not an infrequent speed for an occasional mile or two. There are engines now running that have made over 90 miles an hour, hauling regular trains.

These figures are very pretty to read, and we may justly regard them as among the glorious achievements of our century. But what will happen when we are called upon to stop from such speeds? With good conditions, with an express train fitted with air brakes up to the best standard practice, with a dry rail and a level track, we may expect to stop an ordinary passenger train within about 1,200 feet from a speed of 60 miles an hour. Under such conditions, however, if we attempt to stop from a speed of 90 miles an hour, we shall find that at the end of the sixteenth second after making the application of the brake we are still running at 61 miles an hour, and we shall have run about 1800 feet in those 16 seconds.* We may then hope that our train will stop about 1200 feet further on, making the total distance run, from the time the signal to stop was acted on, 3,000 feet. This, be it observed, is when all conditions are favorable. Let the reader pause a moment and try to imagine how he would feel if he were in the cab of a locomotive running 90 miles an hour and saw the track ahead fouled by a wreck on the track alongside. Let us hope that he would keep cool and do his duty; still, he would have a poor chance of getting out of the scrape alive.

The problem of designing a brake apparatus that shall be simple enough for ordinary working and that shall permit the application of much higher pressures than are now used at the beginning of a stop, and the gradual reduction of the pressures as the speed goes down, is one to which Mr. Westinghouse has given a good deal of attention. Such a "reinforced" brake is now in use on some of the fastest trains that are run; but I fear that humanity can not hope soon to be able, in regular railroad working, to annihilate the energy of 90 miles an hour, or even of 75 miles an hour, in the time and space that now serve to stop from 50 miles an hour. If people will run trains at over 50 miles an hour, they can hope for reasonable safety only from a complete system of signaling, laid out and worked with reference to the highest speeds run; and for very high speeds this signaling must provide for giving warning at much greater distances than are now provided for.

No attempt has been made in a number of years to ascertain what proportion of the mileage of the railroads of the United States is protected by block signals. In England practically all main line on which passenger traffic runs is block-signaled. I should be surprised to learn that as much as 5 per cent. of our own mileage is so protected. It is a singular fact that in the year of the Columbian World's Fair only one of the trunk lines had an unbroken system of block signals from New York to Chicago, and that was the Erie.

The growth in the use of interlocking signals for the protection of crossings, junctions, and all sorts of switches has been great within the last decade, and in this respect the railroads of the east are fairly well protected for usual speeds; but the signals are not often far enough away from the danger points for the high speeds sometimes made.

* See a communication from Mr. George Westinghouse, Jr. in the *Railroad Gazette*, 1892, page 697.

Furthermore, the adequate signaling of a railroad is not merely a matter of safety. For high-speed trains it has another function,—to minimize delays. If very fast time is to be made, it is important that the engineman should never be left in doubt whether or not his way is clear. He must be able to approach fixed signals without relaxing speed,—with confidence that, if he must stop, or get ready to stop, he will get notice in time, whatever his speed. To this end distant signals must be put far enough from the home signals to allow ample time to get "under control" before the home signal is reached, whether the rail is wet or dry, whether the night is clear or foggy, and when the speed is the highest that is ever made in that part of the run. These suggestions are enough to indicate how the signaling of a railroad must be affected by any important increase in the speed of its trains.

But there is a class of stops that cannot be provided for by any system of signaling. On a double-track road a wreck on the west-bound track may foul the east-bound ; a landslide may block the track ; a drunken or careless driver may suddenly appear on a country road-crossing ; a dozen things may happen that signals cannot provide for. When we think of these emergencies and remember how hard it is to stop from very high speeds, we begin to realize the responsibility which a management assumes when it undertakes such speeds, and we suspect that the public has but little conception of its own responsibility in demanding them.

We have considered briefly some of the relations between fast running and the material of railroads ; it remains to see what effect speed has, or is likely to have, on the men.

Sustained journey speed, from end to end of a run, is not merely a matter of high speed between stations ; it involves also making the station stops short. The more stops there are, the more important is promptness at stations. The observant man who travels much cannot fail to notice the effect on trainmen, on stationmen, and even on passengers, of habitual fast running. All hands get trained to alertness and precision of movement. It is a fine thing to watch the handling of a very fast train at a station. It is invigorating to see the speed without haste of the inspectors and the baggagemen, the quick and smooth change of engines, and the cutting off of the dining-car. I have seen the other extreme on a southern railroad, where the easy-going conductor ran past a flag station and then backed down a mile to let off one passenger. His serene indifference to time did not make me feel any safer on his train.

There is great mental and moral value in a training which makes men keen and alert, and breeds the habit of concentrating the faculties, and we may reasonably suppose that this tonic effect of fast trains goes all through the service. We may suppose that the engineman is more attentive to his machine and to the signals; that the signalman and the dispatcher will do their work better, if they have less time to think about other things; that the trainmen, freight and passenger, will take better care of their trains and of outlying switches on a road where the force is keyed up to fast time; that the trackmen will be held to greater efficiency in their daily work and to greater vigilance in patrolling. On the whole, *so far as discipline of the force affects the matter,* we may look for greater and greater efficiency and economy as the result of a considerable increase of speed.

In this hasty survey we have seen that the high speeds of recent years have increased the weights carried on driving wheels, and of course the severity of the blow delivered by the drivers has increased with the speed as well as with the weight. We have seen also that the weight of rails and bridges has been increasing along with the locomotive wheel-weights. We have seen that, if trains are to run more than 60 miles an hour, reasonable safety requires a standard of signaling not yet attained on the railroads of the United States. We have seen, too, something of the effect of speed on railroad men,—a topic that I should have liked to develop at more length had space permitted. In the first article of this series I attempted to show some of the relations between speed and the volume of passenger travel. At the end of the series I realize how inconclusive the inquiry has been. Indeed, the important question of freight-train speed, a matter affecting revenues and cost of working even more than passenger speeds affect them, has been left entirely untouched. But perhaps some lines of inquiry to be followed by other students have been suggested. At any rate this we can safely conclude,—no man will be contented so long as *any* time or space separate him from his interests or his desires. Therefore, the railroad officers can safely act on the belief that the limit of railroad speeds is not yet in sight.

THE COST OF IRON AS RELATED TO INDUSTRIAL ENTERPRISES.

By George H. Hull.

THE steadying effect of an ample visible supply of any staple article of manufacture is apparent, but the importance of this in the case of pig iron is far from being appreciated. In fact there is in the United States no great staple article that is allowed to drift so helplessly in the storms and sunshine of trade as this important product.

It is generally admitted that no manufacturing business can be safely carried on, or made reasonably continuous and profitable, if it depends upon a raw material that is subject to great fluctuations in price. Iron enters more generally into all the great enterprises and improvements of this age than any other staple. It is, therefore, of the first importance that the fluctuations in its price should be confined within reasonable limits; otherwise the business of the whole country must be disturbed, when these excessive fluctuations occur.

To realize how important the price of pig iron is to a long continuance of the prosperous condition of general business, we have only to consider the universality of its use, and to examine the effect its fluctuations have had on the business of this country in the last fifty years.

The history of pig iron in the United States is a succession of periods embracing a quick and enormous advance in price, followed by a quick and enormous decline, resulting in several years of depression and unremunerative prices. These abnormal advances have been caused in every instance by the small surplus stocks carried in the United States, and the struggle of each manufacturer to obtain enough to supply his needs, at each recurrence of a general revival in business.

It was the revival in business and small stocks in 1854 which carried iron from nineteen dollars to fifty dollars. Everything was prosperous, but fifty-dollar iron put a stop to many of the great enterprises; thousands of men were thrown out of employment all over the country; the new furnaces built on high prices came into blast, prices commenced to tumble, and the great panic of 1857 resulted; the price of iron had fallen to twenty-seven dollars,—but it did not stop there: it continued to fall, until it reached eighteen dollars in 1862. The five years of depression ruined furnacemen, right and left, and many of their plants fell into decay.

Stocks were again at a low ebb when the revival of business in 1863 put iron on the up-grade again ; there was an actual famine in iron. Prices jumped several times, as much as five dollars per ton in a single day ; but even fifty-dollar iron could not stop the prosecution of the war and its attendant necessities, and iron during the following year reached eighty dollars per ton in the middle States and seventy-four dollars per ton in the east.

After the great war-consumption ceased, iron dropped to thirty-five dollars (in 1870), but the increased demand of 1872 put the price up to sixty dollars in the middle States ; again the great enterprises were stopped by the high prices, and the panic of 1873 soon followed. Within the first year of the panic it dropped to thirty-five dollars, which was less than actual cost in the middle States, labor and all raw materials entering into its production having advanced so largely in 1872 ; but it did not stop at thirty-five dollars. It continued to drop, until it reached twenty dollars in 1879, and in these six years it was produced at a constant loss, as the decline in the price of iron always precedes, by a long period, the reduction in the cost of its manufacture. Again, in 1880 the small stock and renewed business carried iron to forty-five dollars.

Will anyone claim that these enormous advances were not important factors in stopping the building of railroads and other large enterprises in each of the periods named, or that the discharge from employment of many thousands of workmen, which this stoppage occasioned, was not the beginning of the panics that followed ?

No other great staple is subject to these enormous fluctuations, for the reason that larger stocks of the other staples are carried ; but just in proportion as you stop the consumption of pig iron, the consumption of lumber and most other great commodities is checked.

It must, therefore, be admitted that a large accumulation of surplus pig iron in seasons of dullness is the only condition that would prevent these enormous advances in price when prosperous business periods return ; but the question is : how can these large surplus stocks be accumulated and carried without injury to the furnace business ?

Experience proves that the manufacturers of pig iron rarely carry a combined stock exceeding two or three weeks' production, and that the accumulation of even one additional week's production will carry prices down unreasonably. Manufacturers make their iron to sell ; if they cannot get one price, they will usually take a lower. Some of them have money enough to accumulate iron ; others have not. The poorer furnaces, which are compelled to sell, lead the decline, and the rich ones must accept the price made by the poor ones.

Experience proves also that consumers of pig iron will not carry large stocks. Among the few that have surplus money in their business, some addition is made to stocks when prices are going up; but, in the several years that prices are going down, consumers generally buy to supply only their immediate wants, and at no time is their stock so light as at the end of several years of depression.

As a broad principle, then, large surplus stocks of pig iron will not be carried by either the manufacturer or the consumer. It will be done only by some middle element, as is the case with other great staples.

In the case of general articles of trade, like dry-goods and groceries, it is done by the jobber and retailer; this we will designate as "natural carriage." In the case of large staples, like cotton, grain, petroleum, provisions, and pig iron, it can be done only by storing the article itself, issuing a negotiable certificate against it, and bringing about general dealing in these certificates on exchanges; this we will designate as "certificate carriage," or "warrant system."

Every great staple except pig iron has had this "certificate carriage" established for it in this country. In the case of each of these staples the majority of the producers at the start have been unfavorable to the introduction of that particular commodity on exchanges. They reason that, if the small "natural carriage" of surplus stocks depressed prices, a large "certificate carriage" would depress prices more violently still. They reasoned, too, that the fluctuation in that article would be increased by its introduction to exchanges.

A careful examination into the history of every staple article that has been introduced by certificates to exchange dealings proves that both of these theories are unfounded. On the other hand, an exhaustive examination shows that the extreme fluctuations have ceased, in the case of each of the staple articles, after the introduction of that article to exchange dealings. We will give but one illustration.

Petroleum, before it was introduced on exchanges, showed violent fluctuations for nine years, ranging from fifty-two cents to seven dollars and eighty-eight cents per barrel at the well. A surplus stock of a half million barrels carried the price down to fifty-two cents. The extreme fluctuation for nine years after it was introduced to exchanges was from sixty-four cents to one dollar and six cents, and a surplus stock of thirty-six million barrels carried the price down only to sixty-four cents. Every great staple that has been introduced to exchange dealings in this country has experienced like results, the producers of these articles, as well as the consumers, realizing a steadying effect not experienced before.

Just in proportion as pig iron enters into the general business of this country will the general business of the country be benefited by the introduction of a system that would curtail the violent fluctuations in its price.

It is believed by some that this "warrant system" will not absorb large stocks of pig iron, and they cite the fact that even moderate lots of ten thousand or twenty thousand tons of speculative pig iron, such as have been carried during various time in the last twenty years, have always depressed the price; but they lose sight of the fact that these speculative lots have been carried by unnegotiable storage receipts, and such carriage has always been, and always will be, harmful to the iron trade. There is, however, between this carriage and the carriage by a negotiable certificate dealt in on exchanges the widest difference.

This "warrant system" has existed in Scotland for over fifty years, and for thirty years out of this time surplus stocks of pig iron in Scotland had been equal to from six to twelve months' production. During one period the stock for five years in succession exceeded a year's production.

What better assurance can there be of the benefit of this system than its fifty years' history in Scotland? That market has not been subject to the violent fluctuations which have occurred in the United States, and the manufacture of iron in that country has been more uniformly profitable.

Many believe that the investing and speculative public will not absorb a large stock of pig iron through exchange dealings, but there is no real foundation for this doubt. The public will not carry unnegotiable storage receipts, just as the public would not carry petroleum stocks until they were put in proper shape; but, as soon as these stocks were represented by exchange certificates, the public quickly absorbed thirty-six million barrels, and carried it without any depressing effect, and that same public will carry all the surplus pig iron that can be accumulated in this country under the "warrant system."

More than one-fifth of the entire wealth of the United States to-day is invested in the carriage of property represented by certificates. The addition of stocks, bonds, and certificates on the New York Stock Exchange alone averages about four hundred millions per annum. It is really the only shape into which property is put in which the money may be said to seek the property. There is no reason to doubt that this class of money-owners will absorb all the surplus iron that is represented by negotiable exchange certificates. They have absorbed like certificates for all the surplus cotton, grain, petroleum, provisions, etc. The actual expense of carriage to the investor, on pig iron, is about one-fourth what it is on all these other great staples. It is this feature that has tended largely to make pig-iron warrants the favorite speculative commodity in Great Britain for many years.

We have had no such violent fluctuations in price of iron during the last ten years as we had during the thirty years previous, for the reason that we have had no such violent and long-continued panics, and the cost of iron is permanently lower; but the moderate revival in business in 1889 and 1895 caused an advance of seventy-five per cent. to eighty per cent., and these ruinous fluctuations will continue until large surplus stocks are carried.

This "warrant carriage" not only is a benefit to the trade during seasons of business activity, but is of equal benefit in another way during seasons of depression,—by absorbing the surplus as it is made, thus enabling the furnaces to continue in blast, without overloading and depressing the consumers' market, whereas, without this system, the furnaces go out of blast in about the proportion that the consumers cease to buy. We have had an illustration of this during the last few months.

In the Shenango and Mahoning valley, where the "warrant system" had not been adopted, there were, in January, 22 furnaces in blast, 19 of which had gone out of blast by August 15. In the Alabama and Tennessee district, where the "warrant system" had been adopted by most of the furnace companies, there were, in January, 32 furnaces in blast, only 7 of which had gone out of blast by August 15. In fact, every furnace company in the southern district which had adopted the system was not only able to keep its furnaces in blast at the time of greatest depression, but was able to sell, through exchange warrants, all its surplus stock at satisfactory prices.

An effort to force off ten thousand tons in the first-named district during the depression in August resulted in only a small sale, at one dollar and fifty cents per ton below quotations, whereas, in the southern district, where the system had been adopted, fifty thousand tons were easily sold by warrant, at the same time, on a concession of ten cents per ton, followed by a sale of another fifty thousand tons at a substantial advance.

The conditions in these two districts were very different, but this does not affect the point we wish to illustrate,—namely, that the previous introduction of the "warrant system" in the south had created a trade for southern warrants which quickly absorbed all the surplus iron as soon as the demand from the consumers ceased, a condition wholly lacking in the valley district.

A prominent iron master of Great Britain recently said, in reply to a question as to the usefulness of the "warrant system" to producers and consumers in Great Britain:

"They simply could not get along without it. It is a necessary adjunct to the iron business. Consumers and dealers who desired to make prices on large lots of manufactured iron and steel for long future delivery would be obliged to take a large risk of the market, if it was not for the 'warrant system.' As it is, they can always protect themselves on these bids by purchases of warrants. Then from the producer's point. Furnace companies having on their yards a large stock of iron, or a large stock of raw material, if they anticipate a decline in the market, can telegraph to Glasgow and sell ten thousand to twenty thousand tons by warrants within a few minutes, without affecting the price more than one or two pennies, whereas, if they attempted to sell a like amount of iron to consumers, they might be a week in doing it, and would depress the consumers' market as many shillings, as they would pence by selling on the warrant market."

The general adoption of exchange dealings in pig iron would enable the producers to market all their surplus product in times of depression, without undue lowering of prices.

The accumulation of large surplus stocks through this means would not prevent a reasonable advance in prices in seasons of large demand, but would prevent the enormous advances which quickly hamper and eventually paralyze great enterprises.

"Stability of value is the safeguard of the producer and consumer alike."

RAILROAD BUILDING AND MANGANESE MINING IN COLOMBIA.

By Eduardo J. Chibas.

AS the United States become more and more settled and developed, and as industries of all classes and the various means of transportation by land and water rapidly multiply, the fields for the investment of capital with expectations of obtaining a high rate of remuneration become narrower, and the natural desire to obtain a larger return has turned the eyes of capitalists to the vast and yet undeveloped countries of Spanish America, whose wonderful natural resources are still hidden in the heart of its mountains or in the thickness of its almost impenetrable forests, simply awaiting the activity, energy, and industry of men to give them a commercial value in the markets of the world.

The object of the present article is to describe the work carried on by an American corporation—the Caribbean Manganese Company, of Baltimore, Md.—in the Department of Panama, Republic of Colombia, to develop the manganese mines of that region.

Before entering, however, into the subject-matter, it is pertinent to say a few words as to the nature of the surroundings and the peculiar conditions under which the company had to labor. The country lying between Nombre de Dios and the mines was covered by a tropical wilderness, some portions of which had never been penetrated by man. Both terminals of the railroad were located at a considerable distance from the established lines of communication with the outside world, making it difficult to obtain supplies and material with which to start operations; and the port of Nombre de Dios, about forty miles northeast of Colon, was entirely unknown to the commercial world, although it had been visited and named by Columbus on his fourth voyage, in 1502. Tradition has it that, while sailing along that coast, he was driven by a storm into this port, and he was so thankful for having escaped the tempest that he exclaimed when he landed: "En nombre de Dios fundaremos aqui un pueblo," meaning: "In God's name we shall here build a settlement." His wishes were fulfilled eight years later by Diego de Nicuesa, who founded on the same spot the town of "Nombre de Dios." This settlement increased in population and prospered till it was partly destroyed by the Indians in 1584, when, by a royal decree issued by Philip II, king of Spain, the place was abandoned, and the town transferred to Portobelo, twenty miles to the westward. At present

THE MAIN STREET OF VIENTO FRIO.

only a few remnants of brick and stone foundations mark the site of old Nombre de Dios, about a mile and a half from the present headquarters built by the Caribbean Manganese Company.

During all the preliminary surveys and a large portion of the period of construction the company made its headquarters in Viento Frio, a native village on the coast, five miles east of Nombre de Dios. The nearest post office, or place to obtain supplies, was Colon. All communication between this latter place and Viento Frio had to be made by sea, as tropical jungles and swamps barred the way by land.

LOCATING THE LAST MILE OF THE RAILROAD.

CLEARING THE LINE OF THE RAILROAD.

There being no steamboats in that portion of the country, it was necessary to rely entirely on sloops for our coast service. One of these, with the suggestive name of "The Hard Times," was bought by the company in Colon, and for a long while furnished the only means of communication with the outside world.

Her extreme length was twenty-five feet. She was completely decked over and provided with two hatchways,—one giving access to the hold, the other to the cabin towards the stern. With fair wind the trip could be made in six or seven hours, but with head wind and adverse current, or during the season of calm, it took two or three days. On one occasion, in going from Viento Frio to Colon, the writer was caught in a spell of prolonged calm, and, after having been out four days and three nights, had been able to cover only half the distance. At the end of that time it was decided to leave the "Hard Times," and make the remainder of the journey in a canoe, or native dug out, paddled by two Indians. A landing was made in Colon twelve hours later, at the end of four days of traveling, in which only forty-five miles had been covered. During the winter, or dry season, the sea in that portion of the coast is very rough, and the journey becomes a somewhat perilous undertaking. The writer has a very vivid recollection of his first trip on the "Hard Times," which was made at that period of the year. We left Colon before sunset with a light wind that kept gathering strength till midnight, when we were threatened with a severe squall. By this time clouds had gathered overhead, and blackness so completely surrounded us that it was impossible to see the entrance of the small port towards which we were steering for shelter, save when the lightning showed us the way. Finally we succeeded in anchoring in a safe place, and, after taking in the sails, we spread a canvas awning over the deck to protect us from the rain, that shortly afterwards poured down. The protection, however, was only partial, as the drippings from the canvas and the rain that blew through the sides had drenched us to the skin long before morning. After encountering a few more squalls, but less severe, we arrived in Viento Frio on the morning of the third day. This village is inhabited by a few hundred natives, living in a very primitive fashion. Their dwellings have thatched roofs made out of palm leaves and sides of wild cane, or of native board formed by splitting and flattening out the palm tree. The peculiarity of these native huts is that not a single nail enters into their construction, all the frame work being tied together with vines.

Owing to the difficulty of transporting building material from Colon, and for the sake of economy, all the dwellings put up by the company during the period of construction were similar to the native huts, though they had a pine flooring. The thatched roof is the coolest covering for that climate, but has two serious inconveniences: it is apt to catch fire very easily, and is an attractive place for small snakes and various insects.

The first work in connection with the railroad was the reconnaissance, or exploration of the country between the coast and the mines, in order to determine in a general way through what portions of the country it would be advisable to make the surveys. The only instru-

A CUT ON THE VIENTO FRIO BRANCH.

CUT AND FILL AFTER PASSING LA GUACA.

ments used were a pocket-compass and an aneroid, the former to get general directions, and the latter to determine approximately the heights of the hills to be crossed. After this was completed, the preliminary surveys were started. This work, like the previous one, proves to be a very laborious undertaking in those countries, as the first difficulty that confronts the engineer is a thick tropical jungle, where, at times, he cannot see fifty feet ahead of him, and the absence of roads or even footpaths makes it impossible to move without cutting one's way with the native machete. The surveying party stayed

WORK-TRAIN AT THE BALLAST PIT.

COMPANY HEADQUARTERS, NEAR NISPERO MINES.

in camps built along the road, about three miles apart. These camps were temporary affairs, put up by half-a-dozen natives in one day, and consisted of posts supporting a palm roof. They had no sides, and were just large enough to accommodate the party. It being impossible to use pack-mules to carry the camping-outfit, that work had to be done by men. Some of the natives, especially in the interior, possess great power of endurance; they will walk up and down mountains with a weight of two-hundred pounds strapped to their shoulders, with apparent ease. Strange as it may seem, they

THE BALLAST GANG.

live almost wholly on a vegetable diet, making use of meat only at long intervals. The rainy season set in before the surveys of the mountainous portion were finished, and for several days it was necessary to work in showers that occurred at short intervals. The only means of drying clothes was by the evening camp-fire, when the stillness of the night would be broken, now and then, by the night-cry of some wild animal in the adjacent forest.

After the preliminary surveys had been completed and the writer's report had been accepted the final location for the railroad was made, as well as all the plans and estimates for the entire work, and clearing of the line was started. To be able to appreciate the nature of the battle against such an exuberant growth, it is necessary to have actually grappled with the problem. Some of the illustrations will

A PARASITE, LOCALLY KNOWN AS THE TREE-KILLER.

give a better idea of the grandeur of the vegetation than it is possible to give in words. One of them shows a parasite locally known as "matapalo," meaning tree-killer, because, when it begins to grow, it winds itself around the large trees and continues growing until it assumes such proportions that the parent tree succumbs in its grasp and begins to decay. To give an idea of the rapidity with which vegetation grows in that climate, combining extreme moisture and high temperature, it may be stated that, after the clearing of the line had been completed, the work was suspended for seven months, and, when it was resumed, the bushes had attained a height varying from five to seven feet. As soon as this new growth had been cleared away (in January, 1894), the active work of construction was begun, start-

A SLIDE IN A CUT, DUE TO HEAVY RAINS.

ing with the excavations. The total amount of material removed from cuts or thrown into embankments was 94,670 cubic yards. The sides of the clay and earth cuts were left at a steeper inclination than the customary 1 to 1 slope, and, with few exceptions, they stood well. This greater stability in the tropics, in spite of the heavy rains, is probably due to the absence of frost, which is one of the principal agents of disintegration in colder climates.

The unloading of the material gave considerable trouble, as, on account of certain legal difficulties, it was necessary to build the road

SIDE-HILL CUT NEAR BELLA VISTA.

BUILDING A TRESTLE.

first from Viento Frio to the mines, and not until this portion had been almost completed could the line be extended to Nombre de Dios.

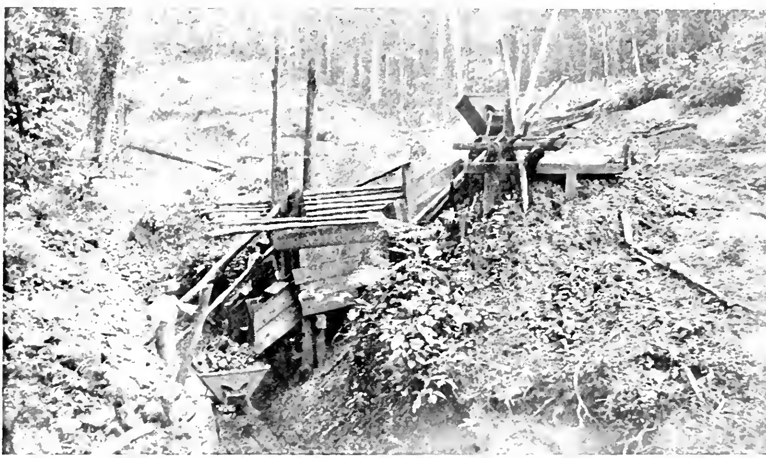
The schooner that brought the material could not anchor in front of Viento Frio, on account of the heavy sea prevailing at the time ; so she had to proceed to Nombre de Dios, where the cargo was transferred to lighters, which were towed to Viento Frio by an old and small wooden steam-tug that had been secured for temporary use. Before half the cargo had been taken out, however, the tug was wrecked. This made it necessary to transfer the rest of the cargo to

CONSTRUCTION OF BRIDGE NO. 38.

THE FIRST CLEARING AT NISPERO MINES.

the beach at Nombre de Dios, and the lighters were moved back and forth by pulling on a rope stretched from a tree on shore to the stern of the schooner, anchored about 1,500 feet away. After this operation had been completed, more than half the cargo, made up of rails and lumber, lay piled on the beach. To transport it by land was out of the question, and there were no sloops along the coast willing to handle such a cargo. Finally all the lumber was transported in rafts towed by natives in their canoes, and the rails on one of the thirty-ton flat bottom lighters temporarily rigged up with a mast and sail. As this

A MANGANESE BOULDER ON TOP OF NISPERO MOUNTAIN.



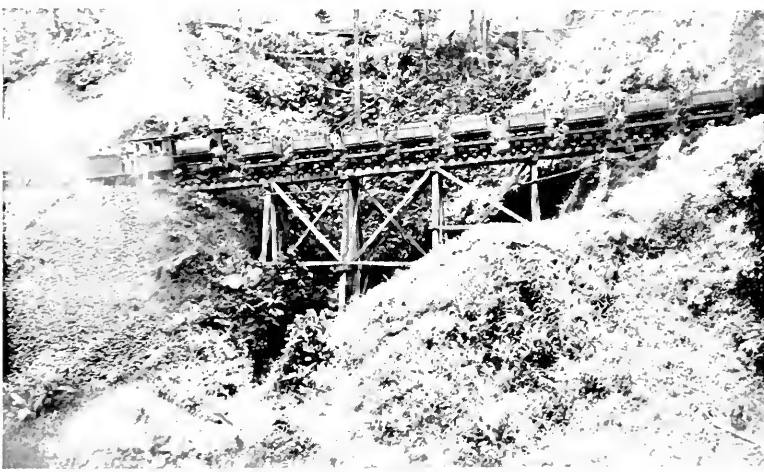
CHUTE BETWEEN FIRST AND SECOND LEVELS OF THE ORE-TRACK.

lighter had not been built for sailing purposes, she required careful handling, and had to be helped at times with oars, and very often by warping,—a process that consisted in hauling on a rope fastened to an anchor previously dropped by a row-boat about five hundred feet away from the lighter and in the direction in which it was desired to move her. In this manner, and after delays caused by heavy seas, the whole cargo was got safely to Viento Frio. When enough material was on hand, track-laying was started. Shortly afterwards the locomotive was put on the track and used to haul carloads of ties,

CHUTE BETWEEN TWO DIFFERENT LEVELS AT MINES.

rails, and bridge-lumber to the end of the track already laid. It was also used to distribute along the line ballast taken from three different cuts containing appropriate material, so that the road-gang, tamping and lining the track, could follow the track-laying gang as closely as possible. The track is composed of thirty-five-pound rails spiked to ties six feet long and distributed at the rate of about 2,200 ties to the mile. The gage is three feet.

In the nine miles traversed by the railroad a great variety of natural difficulties were met,—from the shallow lagoons and swampy ground that covered portions of the first three miles to the broken and mountainous country that characterized the latter portion of the line, where it was necessary to adopt a maximum grade of five per



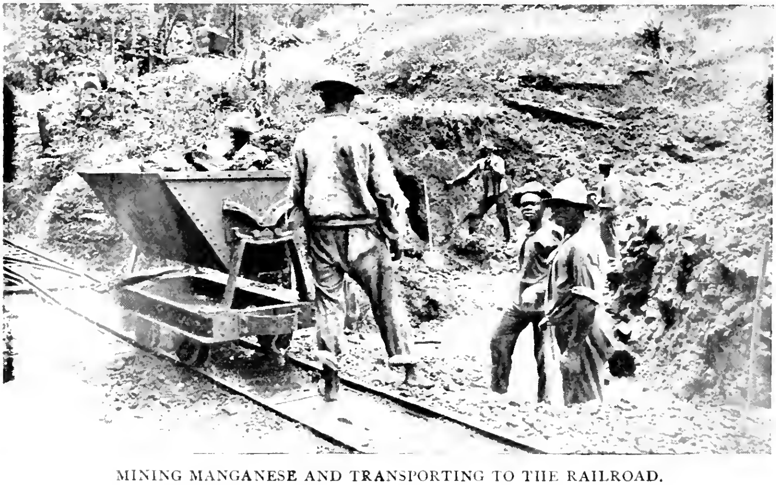
A TRAIN OF ORE GOING DOWN THE 5% GRADE.

cent., in favor of traffic, and maximum curves of 40°, 146 feet radius, so as to be able to follow along the flanks of the mountain with the least possible excavation. By using the lower limit of curvature usually adopted, the cost of the railroad would have been made so great that the enterprise would have been an impossibility from a financial point of view, but, by a judicious use of sharp curves, the cost was brought within economic limits. The curves constitute more than one-third of the total distance, and, placed in succession in one direction, they would make ten and a third complete circles. There were so many creeks and ravines that it was necessary to build thirty-nine bridges, aggregating nearly half a mile in length and varying in height to thirty feet. The total amount of lumber used was 121,800 feet, board measure, and 374 piles. The latter were of native timber,

A GRAVITY INCLINE, THE LOADED CAR PULLING UP THE EMPTY ONE.

and aggregated $1\frac{1}{4}$ miles in length. Of the former one-third was of Georgia pine, and two-thirds of native timber.

When the railroad was nearing completion, operations were begun at the mines. The manganese is found on the flanks of a steep mountain. The outcrop near the summit, shown in one of the photographs, is about 500 feet above the Nispero terminal of the railroad and 2,000 feet from it horizontally. For the first few months nearly all workings were on the surface and confined to a belt about a quarter of a mile in length and at a maximum elevation of 200 feet above the



MINING MANGANESE AND TRANSPORTING TO THE RAILROAD.

railroad track. The ore was handled at the mines by means of portable track and one-ton iron side-dumping cars. The tracks were laid along the hill side at different elevations, the vertical distance between them being 25, 50, or more feet, according to the distribution of the ore. They were laid at a light grade of from 1½ to 2 per cent., allowing the loaded cars to go down almost by themselves, and at the same time not requiring much exertion on the part of the men to push up the empty ones. The levels were connected by ore chutes built of planks and rough logs from the neighborhood, and with a minimum inclination of 45°, allowing the ore to roll down easily. At the bottom of this chute there is a gate which, when lifted, lets the ore drop of itself into the car standing below it. The ore was also brought

ORE-BINS FROM WHICH RAILROAD CARS ARE LOADED.

down from the highest to the lowest level by an inclined plane, the force of gravity making the loaded cars on their downward journey pull up the empty ones. The mining cars in the lower level emptied into the ore bins, from which four railroad cars could be loaded at the same time in a few minutes, by lowering the gates and allowing the ore to run out.

A word about the harbor work. Nombre de Dios has an outer harbor and an inner one. The latter is an inlet looking more like an artificial than a natural channel. It varies in width from one hundred to two hundred feet, and its navigable length is about eight hundred feet. The steamer, when inside, cannot turn around ; it has to come in or go out stern first. This was made easier by anchoring a buoy at the head and another at the terminal of the channel, so that, by fasten-

DRIVING PILES FOR THE WHARF AT NOMBRE DE DIOS.

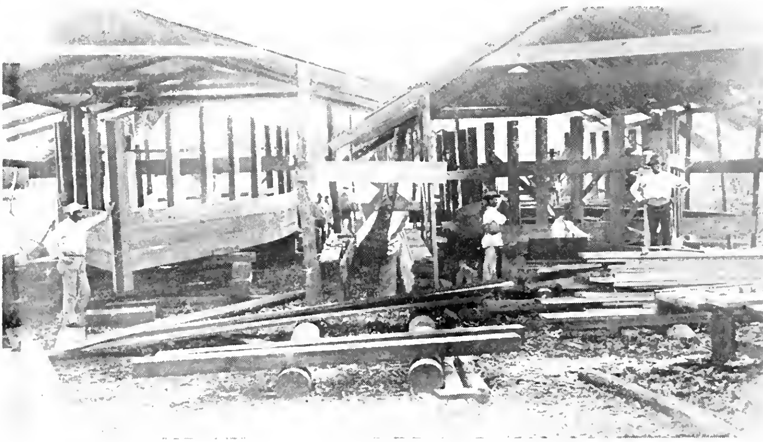
ing a chain or rope to either, the steamer could haul itself in or out. Iron rings placed on both shores, through which guide ropes could be slipped, served to keep the ship in midchannel. Both shores are lined with coral reefs, and deep water comes close to them. For this reason it was possible to build the wharf, with its length of two hundred feet, parallel to the shore, while its width did not have to exceed fifty feet. The piles for the wharf were shod with iron points, as most of them had to be driven through coral rock. The steamers are loaded by placing the manganese in ore-buckets supported by car-

THE STEAMSHIP "EARNWELL" LOADING ORE.

LOADING THE "FARNWELL" FROM LIGHTERS HAULED BY A STATIONARY ENGINE ON SHORE.

trucks that are pushed to the side of the steamer on tracks surrounding the ore-piles and extending to the wharf. These buckets are lifted by the vessel's winches and emptied into the hold. In this manner, by using sixteen buckets it was possible to handle four hundred tons per day of ten hours during the shipment of the first full cargo of ore. The steamers at the wharf can load only from 1,500 to 2,000 tons. To take what they need to complete a full cargo of 2,700 tons or more, they have to move to the outer harbor and anchor about 2,000

ENGINE-HOUSE, CARPENTER-SHOP, OFFICE, AND ORE-DUMPS AT NOMBRE DE DIOS.



OUR VIENTO FRIO SHIP-YARD. TWO LIGHTERS UNDER CONSTRUCTION.

feet from the wharf. One of the illustrations shows the way in which the shipments by lighters were managed without the use of a tug. A hoisting engine stationed near the wharf was used. A rope was passed around the drums, then through a snatch block tied to a tree directly in front, and finally to the stern of the steamer. Thus the lighters were enabled to move back and forth very rapidly.

The arrival of the first steamer to load manganese ore was the crowning event. Therefore the sight, in the early part of May, 1895, of the S. S. Earnwell slowly and majestically moving towards the inner harbor was witnessed with enthusiasm. Nearly a week later, after the cargo had been loaded, and the departing steamer was growing smaller and smaller in the distance, she seemed to be taking away all the hardships and privations of pioneering, and leaving in her wake the beginning of a new era of progress and civilization, marked by all the attending advantages of regular and direct communication with the outside world.*

* Some of the data given in this article are taken from a paper read by the writer before the last annual convention of the American Society of Civil Engineers, on "*The Construction of a Light Mountain Railroad in the Republic of Colombia*," published in Vol. XXXVI of the *Transactions* of the society, and to which the reader is referred for more detailed information.

THE ECONOMY OF THE MODERN ENGINE ROOM.

IV. THE SIGNIFICANCE AND VALUE OF DUTY TESTS FOR ENGINES AND BOILERS.

By E. J. Armstrong.

THE installation of a power-plant presents an exceedingly complicated problem,—one capable of an infinite number of partial solutions, but never so well worked out that further study will not be repaid. The conditions are usually of such a nature as to preclude the attainment of the highest fuel-economy; they are many and various, and are never the same in any two plants. Space may be of much or little value. Preferred types of boilers are often barred by limited height of ceiling. Close engine regulation may be essential or unimportant. Sometimes engines must be capable of making continuous runs of long duration: in other cases a stoppage during the run is inadmissible, and ability to keep going with certainty must be secured, even at the expense of a duplicate plant. The suddenly-applied loads of electric-railway and electric-elevator service introduce features so puzzling that as yet we have not even satisfactory instruments for measuring the power developed, but must go to the electrician's watt-meter. Perhaps an anticipated future demand for greater power must be provided for. The cost and quality of fuel, quality of feed-water, availability of condensing water, cost of repairs, and, to some extent, cost of attendance, vary with the locality, each case having its own set of conditions, which must be carefully studied to obtain the best results. To select the boilers, engines, and other parts of the plant, and lay out the whole so that a satisfactory power-service will be secured, with what in the long run is the lowest cost, is a task calling for the best work of an experienced engineer. It is poor business policy to place it in less competent hands.

An important point which seldom receives the attention due it is the proper proportioning of the engine to the work. The point in its working range at which an engine is most economical varies with its type, its size, and the steam pressure under which it is operated. In non-condensing compound engines of small size and working under moderate pressures the greatest load that can be carried is usually that of best steam economy; in very large condensing engines the lowest point on the duty curve is earlier,—perhaps in some cases as early as one-half of the ultimate load. In simple engines of moderate size it is generally later than two-thirds, and often very near the extreme load which the engine can carry. In the majority of engines the point of best economy is at a load greater than their rated power. It is, therefore, a mistake to use a larger engine than necessary, for, while the duty may be satisfactory at its most economical load, or at its rated power, the average load to be carried is likely to be much less than this,—perhaps at a point where the engine is extremely wasteful. The special conditions always influence the choice, but it is a good rule to figure what size of engine will be required to carry the largest load anticipated, at the lowest steam pressure to be used, taking (with simple engines) about sixty-five per cent. of this pressure as the M.E.P.

It will pay the purchaser, in receiving bids, if he proposes to see that the contract requirements are met by the engine-builder, to require either complete duty curves, or a guarantee of the duty at a sufficient number of different loads, including the maximum, to enable the curves to be constructed. Superimposing these curves from competing engines will show quite differently from the comparison made with the duty guaranteed at one point only. This may seem, particularly to the engine-builder, to be a useless refinement, but it may easily happen that the engine which will sustain the best guarantee at rated power will make the poorest showing with the varying loads which it is destined to carry in actual service, and the method suggested, if properly carried out, will secure better results than the most expert guesswork. The notoriously loose way in which engine guarantees have been made is largely due to the fact that but few plants are ever tested. No matter what the purchaser may expect to do when he signs the contract, the difficulty and expense of making a duty test after installment are great enough, in the majority of cases, to prevent the purchaser, if the engine be not a large one, from doing anything to prove whether or not the contract requirements have been fulfilled. If everything else is satisfactory, an excess of fuel sufficient to pay the interest on the cost of the engine several times over will seldom prevent a settlement in full. This is manifestly as unfair to the engine-builder who makes no claims he cannot fulfill as it is to the purchaser defrauded. So long as the custom prevails of making guarantees of steam-economy, the fulfillment of which is to be determined by the purchaser after the plant is in operation, so long will salesmen make reckless claims, and collect pay for engines which can never, by any possibility, fulfil the representations of their builders. It would seem that the only proper way to contract for an engine of less than three or four hundred horse power is to throw the burden of proof upon the engine-builder by requiring him to test the engine before shipment. Make him guarantee the duty per brake horse power at several loads covering the entire range of the engine, and, by actual trial upon his test-floor, demonstrate to the satisfaction of a representative of the purchaser that the contract requirements have been complied with. In the most progressive shops the testing rooms are equipped with surface condensers, by which the steam actually passing through the engine can be condensed and run into tanks to be weighed; and the loads are produced by Prony brakes, or dynamometers, by which a practically constant load can be maintained, and the power delivered by the engine be measured. The difference between this and the power as computed from the indicator diagrams is the friction of the engine, and is also easily ascertained.

The advantages of this system of testing are very obvious, and, should its use become general, as now seems likely, it cannot but have the effect of raising the standard of engine-design. Although seemingly a hardship to the engine-builder, it is really much fairer to him than the attempt to test an engine for steam consumption after it has become a part of the plant. Testing an engine by weighing the water pumped to the boiler is very liable to serious error. It is certain that a part of the feed-water does not pass to the engine. All boilers leak, even when no leakage is visible; and, while they may be, and perhaps usually are, made so well that this loss is small, it would seem only fair to maintain the working pressure in the boilers for some hours, having all outlets closed and noting the amount the water-level falls, or how much is required to maintain it. This leakage should, of course, be deducted from that charged against the engine. Generally it is impracticable to obtain the delivered or brake horse power after installation, and it is usually difficult to maintain a sufficiently constant load for the indicator diagrams to afford a very reliable record of the i. h. p., unless they are taken at much shorter intervals than usual. Frequently, in making duty tests, the feed-pump must be operated from the boilers from which the engine is drawing steam, and it is impossible to estimate with any degree of certainty the amount so used, except by condensing and weighing it, which is usually impracticable. Long pipes, particularly when large for the engine (as they often are, in plants where several engines are piped to one steam main), condense steam, which is difficult to drain from the pipes, and is apt to come over to the engines in installments rather than in a steady flow. When this occurs, the quality of the steam cannot be properly measured by the calorimeter. There is always, if much water be present in the steam, considerable uncertainty in its determination, and still more in making proper allowance for its presence. While the throttling calorimeter seems to be capable of giving accurate indications of the quality of the sample of steam actually passing through it, it is impossible as yet to obtain a sample which will with any certainty correctly represent the steam passing to the engine. The liability of error seems to increase with the percentage of moisture carried by the steam. It is customary to deduct only the amount of water which the calorimeter readings show to be present in the steam, from the amount passing through the engine. While this water, by its presence in the cylinder, may sometimes cause little loss beyond its own amount, under other conditions it may, seemingly by increasing cylinder condensation, cause a loss several times greater than the actual amount of entrained water, the bad effect is greatest at light loads, and early cut off, becoming very small at the maximum power of the engine. It also seems to be greater at high speeds, and is probably greater in small engines than in large ones. It is, therefore, impossible to make accurate allowance for wet steam. If the piping is short, so that the entrained water comes to the engine in a steady flow, the percentage as measured by the calorimeter, as recent experiments have shown, is likely to be high. It is also probable that the loss by its presence will be greater than the actual amount ; so we have the comforting probability that the two errors are in opposite directions, and tend to offset each other. By the use of a well-designed separator of ample size the moisture may be reduced to a point where the final error is likely to be small. By the elimination of the uncertain factors the engine-builder can promise duties to be demonstrated in his shop which he could not safely guarantee to show after installment in a plant which might, or might not, offer as favorable conditions. To the purchaser an advantage of this method of testing engines is that the delivered or brake horse power can be more readily obtained, and this, rather than the indicated horse power, is what should be guaranteed.

Loss by engine friction is the worst kind of loss, for it is using up power to wear out the engine. It is not easy to understand how long life of an engine and excessive friction can go together. In well-designed high-speed engines of one to two hundred horse power, the friction may be brought as low as four and one-half per cent. This is, of course, a very exceptional figure, but more than twice that should not be tolerated. The friction in horse power will, in such engines, generally be nearly the same at no load as at about two-thirds of the ultimate capacity of the engine, or near the rated power as usually estimated,—being somewhat higher at intermediate loads, and also at loads greater than the rating. With slow-speed engines the friction is generally least when the engine is running light, and it increases all the way up to the maximum load. To assume the friction from the friction-card is not a correct method, and cannot be relied upon to give even an approximate idea of the engine friction under load.

Tests of boilers are necessary to demonstrate both efficiency and capacity, and there is in use a standard method of conducting such tests, and also of making the guarantees. Some years ago the American Society of Mechanical Engineers appointed a committee to formulate a method of conducting boiler trials, which should embody the best practice, and which could be recommended to engineers. The report of this committee was very full, covering the question of guaranteeing and demonstrating boiler efficiencies and capacities, and has since been generally adopted by engineers as the standard method. The report is too long for reprint, even in synopsis; it may be found in Vol. VI, page 267, *Transactions A. S. M. E.*, 1885. After a plant has been completed and put in operation, its original efficiency may easily be impaired in very many ways, and there should be some attempt made to keep track of the coal and water used and the power developed, to form a check upon serious deterioration. Where all the power is used to drive dynamos, the recording wattmeter and the coal bills may give a rough idea as to whether the original efficiency is being maintained, provided records have been kept from the start for comparison. In other cases resort must be had to the indicator to obtain the amount of power developed. In some engine rooms cards are taken at short intervals through a day's run, and the coal used for that day is weighed, this being done several times a year. Partial tests of this kind, while giving only approximate results, are valuable, if made regularly, as forming a check upon losses which might otherwise pass unnoticed; they are about all the tests the average owner is willing to have made. If the plant is large, it is mistaken economy not to provide for keeping daily records of the coal burned and water evaporated. The water should be measured in tanks, not by meter; it is not very expensive to construct two large square tanks, with a long glass tube and a scale fastened to each to show the height of water. These tanks, properly piped to the pumps, will permit the daily water record to be kept with accuracy. The ratio of the coal and water, or the weight of the water divided by that of the coal, will be found to be fairly constant from day to day. If it changes, effort should be made to locate the cause. The boilers can be used as coal calorimeters of the most practical kind, and the relative values of different qualities of fuel ascertained.

If a good fireman raises the ratio, it is worth something to know that he is better than the average, and probably it will be an aid to correct firing to know each day how he came out the day before. There is no progress made except by investigation, and, in the case of a steam plant, without it there is bound to be deterioration. While elaborate and expensive tests are necessary when accurate information is to be obtained, yet the daily records of coal and water—and occasionally of power—can, in competent hands, be made of much more value in keeping up and improving the plant. If the right man is in charge and given facilities and encouragement, it is truly surprising to see how many chances for improvement can be found, and how many losses detected, not only in the generation, but in the use, of power, which might otherwise have passed unnoticed. With boilers, as with engines, there is a point of maximum efficiency, and, while boiler duty curves are not yet common enough to discuss, yet, in plants where large batteries of boilers are in use, it pays to find out the number of boilers which will do the work with the least coal. Losses occur in the factory which can be detected in the engine room. In many establishments the machinery of transmission uses up the larger part of the power developed; and shafting out of line, or boxes running habitually warm, or perhaps small belts strained up to do double duty, waste coal as truly as a leaky safety-valve. Such things are apt to pass unnoticed, but, if the report comes up from the engine room that the shafting takes ten horse power more to drive than it did a short time before, an investigation is likely to follow.

Perhaps the shafting is fitted with self-oiling boxes, which require filling only once in six months. When the engine is indicated to learn the friction of that shafting near the end of the six months, and again soon after the bearings have been cleaned and refilled, it is probable that the cleaning and refilling will thereafter be done at shorter intervals.

In all establishments where much shafting is being driven it should be one of the duties of the engine-room force to periodically ascertain the power required to drive the machinery of transmission.

EXAMINATION OF CORPORATION ACCOUNTS BY AUDITORS.

By Thomas L. Greene.

THE custom of having a periodical audit of a corporation's accounts by some person unconnected with the management is growing in the United States. It has long been the established practice in England, where auditors are appointed at the annual meeting by the shareholders, and are, to a very large extent, independent of the officers of the company and of the directors. Since, with a return of prosperity, we may expect an increase in the number of corporations formed for transportation, manufacturing, and other industrial and trading purposes which will offer their stocks and bonds for sale, and an increase also in the public interest in all companies, old and new, it is proper that a few words should be said upon the benefits of auditing, and the limits to be placed in the public estimation upon its significance.

For reasons which readily suggest themselves, the American public has, in the past, inclined to put more stress upon the certificate of an examining accountant than the circumstances warrant. A statement of the extreme view about such certificates is found in an article by Mr. J. Selwin Tait in the June number of THE ENGINEERING MAGAZINE, entitled "The Fruits of Fraudulent Railroad Management." Mr. Tait's article is an able, but too severe, review of railroad affairs in the United States. He attributes to downright fraud many investment losses in American bonds and shares which were really occasioned by adverse business circumstances; the fault of the managers in the most of such cases—if fault it should be called—was optimism; the real situation was not faced, and the outcome of bankruptcy considered, but, on the contrary, hopes perhaps not strictly justified were held out to owners of the company's securities. The argument of the management in such instances usually is that, by sustaining the credit of the company, the crisis may be successfully passed; if the company succumbs finally, the security-holders suffer no more because of the efforts to save the property. Notwithstanding a loose impression to the contrary, actual fraud in railroad management is rare.

For both fraud and adverse business conditions Mr. Tait has one principal remedy, and to this remedy, exclusive of many good suggestions made in his article, I shall confine my discussion. That remedy is stated in the following words:

"That auditors shall be elected by the stockholders, and shall have the fullest power to examine the books at all times, and to call upon the president, directors, and officials for whatever explanation or information they may require. That said auditors, who shall be public accountants of unquestioned standing, after examination of balance-sheets, vouchers, books, etc., shall sign and present to the stockholders a statement to the effect that they have examined these carefully, and that the books are properly kept, *and shall exhibit a true and correct view of the company's affairs;* such statement to specify any cause of complaint which has come under their notice." [Italics mine.]

The meaning is plain enough; the investor should rely upon the public accountant, not merely for the verification of the figures on the books, but for a true view of the company's affairs,—that is, for a trustworthy opinion on the values of the company's bonds and shares.

The course of business is comparatively stable in Great Britain; there the changes in the gross and net earnings of the large companies, such as the railways, are slight; but in a new and developing country the fluctuations may be, and often are, great. A statement of profits of an English enterprise, certified as technically correct, may, therefore, be generally accepted as reflecting with fair accuracy the business conditions. But in the United States a judgment passed upon the book-keeping of a corporation is construed to mean much more than in England. Now, it is exactly this extra judgment, really outside the mere figures, which home and foreign investors in American corporations are hoping to obtain; and it is precisely this which was not originally intended to be covered by an ordinary audit of the books. An American railway, particularly west of the Great Lakes, is subject to extreme changes; crop-failure one year and crop-abundance the next may introduce factors whose effect is all important; a war of rates or a shifting of routes may suddenly render worthless the best calculations of the managers; under such conditions an even course of policy is impossible. Take for illustration the question of betterments,—how far they may be charged against income. This question is practically settled in Great Britain, for the comparatively steady course of earnings allows of a fine distinction between expenses and improvements, so that nothing shall be included in working expenditures that can, by any stretch of the rule, be considered as a charge to capital account. Indeed, it is not too much to say that the first duty of the English auditor is to see that every penny of net profit, as technically and strictly defined, shall be paid to the shareholders annually.

But such a construction put upon the accounts of an American railroad would introduce confusion and perhaps financial embarrassment. An American company that paid out all its money in dividends in a prosperous year and devoted little or none of it to works which, according to the English rule, are to be considered improvements and therefore payable by the sale of bonds, would find itself unprotected, and in a bad condition to withstand the "lean" years of business depression. Whether, therefore, all the profits of a company should be paid to shareholders; whether the unused earnings should be set aside for necessary improvements to the plant and equipment, or for the purchase (say) of much-needed terminals; whether these profits could with safety be appropriated in part to such betterments, and in part to an increase in the dividend,—all these are problems to whose solution railroad officers of ability and experience give their best efforts. Is it to be expected that an outside auditor can answer such questions off-hand?

This matter of the charging of the cost of improvements to the proper account is one out of many examples to the same effect which could be given. They all arise from the fact that business and the prospects of business must be fluctuating and changeable in a new country whose resources are not yet fully utilized. It will be clearly seen, therefore, that the auditing of corporation accounts cannot have the same meaning in the United States as in England. The course of trade in Great Britain allows of the application of strict rules to the book-keeping, and the only instruction given to the auditor is to apply these rules, letting the results follow as they may. This fact is recognized abroad by everybody. Books are published, showing how fine is the line dividing the year's profits from last year's losses or from any general expenditure. It is expressly stipulated and supported by the courts that the auditor has nothing to do with the question of the policy pursued by the officers, and this stipulation is carried to great lengths. The auditor is not to question the doings of an old officer or servant of the company, or go behind the returns he may hand in. In a recent case the manager of a company deceived everybody by reporting a false quantity of material on hand, thus increasing profits and assets. The auditor took his word for it, though the simple addition of the year's purchases (less the quantity consumed) to the inventory of the previous year would have disclosed the fraud. The case was carried to the higher court, where the auditor was acquitted on the ground that he was bound to report only upon the books as they stood. This decision follows naturally from the English theory of an audit,—a theory which has, nevertheless, worked well abroad, because business conditions allowed of just such a technical report and were satisfied by it; such an audit does not demand from the auditor any judgment upon the affairs of the corporation or the expression of any opinion thereon, except as the book-keeping itself may require it.

The moment we step outside these strict rules of auditing, we either hurt its usefulness, or we put upon the auditor the responsibility of deciding upon problems which tax the best minds. Suppose that an audit is to be undertaken upon the books of a railway which has accumulated during the year a large surplus and proposes to spend the whole or greater part of it upon improvements, or has already done so. Manifestly the strict English rule would require the auditor to report that this surplus belonged to the stockholders. If he shrank from such a bold opinion, he must, under the common understanding, either directly or by implication, pass judgment upon the policy of the company by certifying to the correctness of the accounting. Or, to take an opposite case, suppose that a company has felt the pressure of hard times, and, believing that future earnings will make up present losses, postpones repairs to plant, refuses to renew machinery, or omits the usual credit to depreciation and reserve. Should an accountant certify to the correctness of the accounts under such circumstances? If we accept the current meaning of an audit, our supposed accountant is between the horns of a very serious dilemma; for what the public (led by the success of strict auditing in England) is really looking for is an expression of opinion on the value of the bonds and shares of the company and on the policy of the managers. Such an opinion does follow to a certain extent from an audit in England, because of the business conditions; and much of our confusion of mind in the United States arises from the natural, but really incorrect, inference that the same thing must be true of an audit in America.

Conditions being different in the United States, auditing here has suffered from another cause also,—the necessary ignorance of the average accountant concerning the requirements for success in each particular line of industry. Again, let it be remarked, the art of accounting as defined abroad does not require this exact knowledge of each company's business to any great extent; but the different situation here, combined with the laudable wish to make auditing mean as much as in the old country, has led accountants in the United States to acquiesce in the common idea that they are expressing an opinion, directly or indirectly, upon the solvency of the company examined. In such attempts knowledge of the details of the particular business in hand is indispensable; and from the very nature of the case it is knowledge which must be hid from the majority of public accountants, who are called from the books of one concern in one line of trade to those of another whose profits depend upon different details altogether. Failures in the past and dangers in the future arise from this yielding of accountants to the pressure of public opinion for what is construed to be a statement of values,—practically a judgment upon the company's prospects, which formed no part of the original purpose of an audit.

Instances of the perils of such construction upon the meaning of an audit are to be found even in the industrial history of England. The Allsopp brewery was sold to an incorporated company formed to take it over. The auditor certified to the profits of the previous year, and the shares, based upon his report, commanded a premium. But the expected profits were not forthcoming, and the subscribers to the new company suffered heavily. A public indignation meeting was called, and the auditor summoned before it. He stoutly insisted that he was right, and had done the whole duty required of a certified accountant; and so he had. It turned out that the profits of the year just before incorporation were exactly as found by the accountant, but were nevertheless unreal in the sense that in that year the cost of materials was lower than ever before. Thus these profits were no criterion of the future success of the new company. Had that accountant been a practical brewer, he would have noticed the fallacy in the books, so far as basing the future upon the past was concerned. One American example may be given. A trading company offered its shares for public subscription in a prospectus which contained an accountant's certificate to the effect that the accounts and bills receivable exceeded the accounts and bills payable by several hundred thousand dollars. When the company became embarrassed, it became known that the bills payable in the prospectus covered money owed to banks, while the accounts receivable were old book accounts due by customers, a good part of which were nearly worthless. Had the accountant been familiar with that business, he would not have couched his certificate in language which was technically true, but practically false, and which made the subscribing share-holders lose their money.

It is precisely this ignorance that is raising a prejudice against auditing in the minds of American corporation officers. They have given anxious thought to the questions of policy in conducting their business, let us say, and have agreed that certain things shall be done in a certain way and paid for from certain funds. Naturally they arrange their book-keeping to suit the facts as they understand them, for that is the very essence of good accounting. A chartered accountant is called in, perhaps to represent foreign shareholders, and proceeds to examine the books. Whether an American or Englishman, he is sure to find entries contrary to the strict and technical rules of the art in which he has been brought up. Having but a superficial knowledge of the business, he is unable to appreciate the explanations given by the company's managers, and perhaps thinks that he has grounds for suspicion. Against the cross-questioning of such an auditor, and against the conclusions which he may feel impelled to draw, the officers enter complaint, and resolve not to subject themselves to the judgment of a man whose opinions cannot be as well founded as their own. No doubt we have in this paragraph the real reason why so many American companies remain deaf to requests for an audit of their books by a professional accountant. That this is not an exaggerated statement can be shown by another quotation from Mr. Tait:

"There should exist a class of carefully-trained professional accountants, whose word is law on all questions of accounts, and who care no more for the opinions of railway presidents on such subjects than they do for that of the least important member of their office."

That is the English theory, but it cannot be applied to the United States. Imagine a public accountant holding President Miller, of the Chicago, Milwaukee & St. Paul Railway up to the indignation of his English shareholders because his company showed a large surplus and paid but 4 per cent. in dividends! or the Chairman of the Louisville & Nashville, because a surplus of a million and a third was earned and no dividend declared! What professional book-keeper, by whatever name known, would set up his opinions on American corporation affairs in the manner indicated in our quotation? or, if he ventured to do so, would not be laughed down?

Another quotation will disclose one reason for Mr. Tait's extreme opinion: "The accountant must be familiar with all questions of law relating to accounts, as well as with the science of accountancy."

Accountancy cannot be scientific; the rigid rules which are applied to one set of conditions cannot be used under other and entirely different circumstances. The *art* of accounting consists in expressing in figures the facts as they really exist. Debiting and crediting are easy, if we are sure that the figures, after they are down, will accurately represent the business conditions; but, without this knowledge, after the best judgment obtainable, book-keeping will only mislead.

We are now in a position to see that the difficulty in which corporation-auditing is involved in the United States arises from the fact that not mere book-keeping is concerned, as is mainly the case abroad, but that a judgment is supposed to be passed upon the corporation's affairs and prospects, and that too by men who have not, and cannot have, given particular attention to the conditions of success in each line of industry. Until business in the United States becomes as stable as in England, the work of an expert book-keeper who has no opinions should be separated from the work of an expert business man or financier who has opinions and is competent to form them. Public sentiment should stop the putting of exaggerated emphasis upon the certificate of a professional accountant, whether the same appears in a prospectus or in the annual report of a corporation. A chartered or certified accountant should put himself squarely in one category or the other; he should profess to be able to pass an opinion on the value of bonds and shares and the prospects of the business, or else he should distinctly have it understood that, like his English brother, his certification is confined strictly to the confirming of the figures as they appear on the company's books. As a matter of fact, it is rare to find good accounting and good financiering combined in the one person; and, as things go, there is room enough in the business world for both accountants and financiers. But, for the sake of clearness, a separation between the two professions should be insisted upon, not only in the interest of accountants, who are now suffering from responsibility thrust on them by the public demand for financial opinions, but also in the interest of the public, which is asking for a mature judgment on investments and is not getting it.

The objection will be made that taking opinion from accountancy will bring down the profession from its present high level. In the first place, if American accountants do not clear their reports from the implication of opinions on value, they will in time become discredited before their readers. But, aside from that, there is a large field, not half cultivated, in which good book-keeping must always be in demand. After all, it is a great benefit for the investor to know that the accounts of his company are kept free, not only from fraud, but from carelessness and from such a system of book-keeping as conceals the facts. An expert accountant need not be asked to pass upon the question, for example, whether a railway ought to carry a branch-line loss in any year as an asset in its balance-sheet; but, if he shall re-arrange the accounts, and so state them that what the company is doing in such cases is clearly shown, he will enable some one else, more competent, to give an opinion. In the Allsopp case, if, in addition to the accountant's certificate, there had been attached a statement from a practical business man or financier who knew the conditions in the brewing trade, it is easy to see how much loss would have been avoided; or, in the case of the American trading company, if the promoters had consulted some one familiar with that particular business, the subscribers would not have been deceived. Holders of corporation bonds and stocks should give up the idea that the certification contained in the annual report is anything more than a statement that the books are correctly kept, and that the report is a true transcript of them; if an opinion on the solvency of the company is desired, such holders should apply to those competent to give it.

ARE ELECTRIC CENTRAL STATIONS DOOMED?

By Max Osterberg.

PRODUCTION on a large scale for centuries past has been considered economical in all branches of industry and commerce. In fact, to contradict this would be almost equivalent to contradicting a geometrical axiom. Nevertheless our progress in electrical and other branches of engineering seems to suggest many points in favor, not of a radical overthrow of this theory, but at least of considerable modifications of existing methods. The writer will endeavor to show that the central station for lighting and power will, in course of time, outlive its usefulness. Just as its growth and development has given impetus to electrical engineering and educated the public to the advantages and comforts to be derived therefrom, so will its offspring, the small isolated plant, be the starting-point for a new era,—that long-looked-and-hoped-for condition where everybody may avail himself, not only of the advantages of the electric light, but of electric power as well, and possibly, too, of electric heating.

On what can we base this statement that the wholesale generation of electricity is more uneconomical than the production in isolated plants? What is it that reduces the expense in practically every known branch of manufacture, and that does not act likewise in this branch? It depends simply and solely on the cost of conveyance to the point of destination, and on the investment required to prepare the path for such conveyance.

Take, for example, the steam road; it is built from the various manufacturing centers to the points of distribution, and the interest on the capital invested in the line-construction is small compared to the value to be derived from manufacture on the large scale. Again, gas is obviously distributed from the outskirts of cities and towns, for the loss of pressure in the gas and even the large amount of leakage, as well as the iron pipes and their maintenance, cost but little in comparison to the value of real estate in the heart of the cities. With electricity, however, this does not hold. Copper, with its necessarily perfect insulation, costs a great deal; if we choose to work on the low-voltage system, the station must be located in or near the center of distribution; otherwise, the value of the copper required for successful service would be prohibitive. Aside from the fixed charges, such as interest and the number of k. w. which must be supplied to the line in order to prevent excessive drops, the generating expenses become exceedingly high. Mr. H. A. Foster, in the *Electrical Engineer*, Vol.

XVIII, p. 188, said that 5.4 cents per k.-w. hour would cover the cost of production.

It can be easily shown that we may install machinery in a corner-building of one block, and generate the electricity on a comparatively small scale at a greatly-reduced cost. Let us assume that we have obtained the permission from the owner of every building in one square block of, say, fifty houses to supply him with the electric current. We may run a steam or gas engine, and we may in either case have storage batteries. The latter become practically a necessity, since we certainly could not afford to keep our machinery running day and night. We can, however, run our engines from about 5 P. M. to midnight, so that only a small storage battery will be necessary for the remaining service. Since, however, in this first calculation, we do not care to include fixed charges, it is immaterial how the plant is installed. We require simply per 24 hours a certain number of lamp-hours. If the average house consumes 50 lamp-hours per 24 hours, then the fifty houses on this one block would require 2,500 lamp-hours, or 137 k.-w. hours. Allowing for losses in the distribution and efficiency of the electrical machinery, we should generate 186½ k.-w. hours. Five pounds of coal per h.-p. hr. would certainly do the work, and we would therefore require 1,250 pounds of coal per day, which, figuring the ton at $3.25, would be $1.81 per day. Allowing for attendance $2.50 per day, and for oil, waste, etc., 50 cents per day, we have a daily expense of $4.81, which per k.-w. hour is 2.31 cents.

Should we care to figure, however, on a gas engine, we should require but, say, 18 cubic feet per h.-p. hr. or, for 186½ k.-w. hrs, 4,100 cubic feet per day, which, even at the high price prevailing in New York city,—$1.25 per 1,000 cubic feet,—would be $5.62 per day. Attendance to the gas engine would be cheaper, however, since it requires no licensed labor to attend it. Adding $2.25 for labor and sundries, we should spend $7.87 for generating 186½ k.-w. hours, or 4.22 cents per k.-w. hour.

The principal advantage of this isolated block system lies in the fact that we have a direct distribution system without the necessary feeders and mains, which, besides their current consumption, involves considerable annual expense when the interest charges are considered. The calculation here presented for the steam plant could not quite be reached, if the boilers could not at the same time be used for heating the buildings; for, in the first place, water tax is not considered; in the second place, it would require too much coal to start fires every day, or keep them banked for eighteen to twenty hours; and, finally, no charge for firemen was added. The figures given for the gas engine, however, can in practice be reached. Equal saving would be made, if oil engines were used in place of gas. Oil engines, at present prices of petroleum, can be run for about one cent per horse-power hour for machines of even one or two horse power, and, since the attendance required is very small, the price per k.-w. hour would possibly go below that of gas.

Suppose that we now choose a certain number of complete blocks, and compare the cost of installation of a large central station with a number of small isolated plants in that district. Take, for example, a section consisting of but half a square mile,—that is, ten blocks long and ten blocks wide, or, in all, one hundred city squares; assuming for each square the same amount of lighting which we figured on before, we should have to build one central station capable of supplying 250,000 lamp-hours per day, with a fair chance of nearly 60,000 lamps at one time,—that is, a station capable of furnishing 30,000 amperes at 110 volts, making a total of about 4,500 horse-power. Such a system would require forty to fifty miles of feeders and mains, regardless of the house distribution. These would require pretty nearly 500,000 pounds of copper, involving an expense of about $500,000 if we include cost of wire, insulation, and laying. Figuring the interest on this item alone at $30,000 per year, the 5,000 buildings would have to pay $6 each per year for the underground distribution. The site and construction of a power station in the center of the city would certainly cost $500,000 more. Machinery, consisting of boilers, engines, and dynamos, would easily add $250,000, and then we would but just be ready to generate our current, a considerable portion of which we should lose by the drop along feeders and mains. We are thus starting with a total initial expense, before entering the buildings, of say, $1,250,000. Were we to put a separate plant into each block,—that is, 100 in all,—with a proper storage-battery outfit and possibly gas engines for running the dynamos, $12,000 to $15,000 per block would easily supply machinery. The rent would be practically negligible, inasmuch as the house in which the plant is installed would be supplied with light at a cheaper rate or would receive a certain amount toward the salary of its janitor, who would take care of the plant. Each building would be charged *pro rata*. One hundred stations would thus have to be installed at a total cost of but $1,200,000 to $1,500,000,—an outlay about equal to that required for the large central station. As far as generating expense is concerned, we have shown already that the isolated plant is more economical than that of a central station. The question then arises how far such subdivision should go; for, since we were able to show that 100 small stations would be more advantageous than one large one, why would not 5,000, or one in each house, be still cheaper? Or is it not possible that one station supplying four square blocks would be cheaper? The answer to this question depends entirely on commercial considerations. That one plant for, say, fifty houses would be cheaper than fifty single plants is obvious from the fact that very small machinery or very small storage batteries are not very efficient; but, with machines of 50 h. p., a practical commercial efficiency can in almost every case be reached.

Apparently, judging from the preceding calculations, the feeder and main system for transmission from central station to buildings, as essential as it may be be for good service, makes the use of electricity still too much of a luxury.

While it has thus been shown that the central station as such may, in course of years, cease to exist, the central-station management may still remain. For example, it might be very feasible for one engineer to take care of ten blocks, charging storage batteries every day. One central management could attend to the repairing of machinery, to the supply of coal where steam is used, or to the wholesale purchase of gas. If such a stage should be reached, pipes for fuel gas would undoubtedly have to be laid through our streets. This, of course, would again materially decrease the running expenses of our small stations, since gas could thus be supplied very cheaply indeed.

Mr. Perry, in his recent paper on "Gas versus Electricity for Power Transmission," published in THE ENGINEERING MAGAZINE, touched on several points which also have a direct bearing on the questions of transmission involved in this paper. He quoted, among other matters, some remarks made by Dr. Louis Duncan, who practically advises the concentration of power with an increased radius of distribution. Such a method, it appears to the writer, would be very uneconomical. It is not fair to compare the problem of railway engineering with the problem of lighting, the conditions being essentially different. In a lighting system we never have occasion (excepting in street lighting, which has not been considered here) to supply one long line extending several miles in one direction. A railway plant can, in almost every case, be included when we treat transmission plants, but cannot be included in the treatment of transmission and distribution combined, except in case of a large network of roads, whose common center could be supplied from one station, with separate plants for the outlying districts.

This question is not an entirely new one, but has frequently been raised. Its best and most obvious reply lies in the constant increase of isolated plants for large buildings.

FIRE-PROOF CONSTRUCTION AND RECENT TESTS.

By A. L. A. Himmelwright.

ONE of the most interesting special problems presented to architects and engineers in recent years is that of fire-proof construction. The fact that fire annually destroys a hundred million dollars' worth of property, or nearly one per cent. of all that we can produce, indicates how important is the subject of protecting property against fire. While the advantages of fire-proof buildings have no doubt been recognized and appreciated for many years, their cost and the experimental stage of fire-proof construction, as well as the uncertainty as to whether they would prove profitable investments, have deterred owners from erecting them. With the advent of our modern high buildings, however, fire-proof construction has become a necessity. The ordinary appliances available for extinguishing fires become inadequate when the objective point of the fire stream is higher than a certain more or less well-defined limit, depending upon varying local conditions. Some of the more recent high buildings are supplied with an independent fire-extinguishing apparatus,—a safeguard that should in all cases be provided in buildings more than one hundred and twenty feet in height.

Practical and efficacious methods of fire-proof construction have been perfected only in recent years. Previous to 1890 the subject of "fire-proofing" had received little scientific study, and the practical work was largely in the hands of ignorant workmen. As a consequence, very few of the so-called fire-proof buildings erected before that time are actually fire-proof. While suitable materials have in many cases been employed in these buildings, they have not been intelligently adapted or suitably disposed. Insignificant fires in such buildings have resulted most disastrously, and in some instances have utterly wrecked the buildings. Careful investigation of the physical properties of structural iron and steel when subjected to heat, and close observation of the effect of fire and water on different materials, have, within a comparatively short time, developed efficient and economical methods of "fire-proofing."

Fire-proof construction, as applied to buildings in general, embraces all methods of protecting the essential structural parts from being injured or destroyed by accidental fires. As applied to our modern steel-frame buildings, and as understood by the building trades, "fire-proofing" may be defined as a special interior construction designed to confine accidental fires to the smallest practicable space, and to so protect the structural iron as to prevent it from being heated or distorted to such a degree as to threaten the safety of the building. The fire-proofing usually consists of some suitable material in the form of arches spanning the intervals between the iron floor-beams. It is also erected around columns, girders, and other exposed iron, and is employed for partitions.

In order that a building may be fire-proof, it is necessary that the fire-proofing material be not only incombustible, but also fire- and water-resisting,—that is, a material that "resists disintegration and retains its strength and firmness under all the conditions that may arise in the case of a conflagration and the subsequent operation of a fire department." The material must also be so adapted and disposed to the best advantage that the desired results are economically secured.

In buildings designed to be fire-proof, combustible material should be avoided as much as possible. The cost of the best materials frequently deters builders from using them, and more or less woodwork is still employed for the interior finish and furniture ; this is an error, but conscientious designers now avoid it, and in the best types of fire-proof buildings the woodwork is largely replaced by metal, glass, cement, and stone. As illustrating the efficiency of some of the best forms of fire-proof construction in buildings with wood floors and trimmings, it may be stated that fires occurring in such buildings are controlled and extinguished without difficulty, and seldom cause serious injury to the building.

The present building laws of New York city prescribe that the spaces between all iron or steel floor-beams in fire-proof buildings shall be filled with common brick or stone arches, or with "sectional hollow brick or hard-burned clay, porous terra cotta, or some equally good fire-proof material, etc." The construction thus legally prescribed, while satisfactory in many respects when carefully executed, has nevertheless the disadvantages of being extremely heavy and very expensive. These disadvantages become more apparent as the depth of the floor-beams increases. The weight of this construction, exclusive of the iron beams, frequently exceeds one hundred pounds per square foot. Its immoderate cost in New York city is due primarily to the fact that the manufacture of the material is controlled largely by a trust, and secondarily to the fact that expensive labor must be employed in placing it.

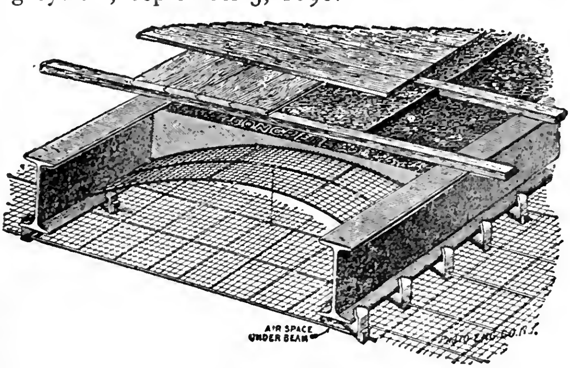
The constant and increasing demand for fire-proof buildings has resulted in the development of forty-seven different systems of fire-proof construction, designed to serve the purpose of the clay products, at a reduced cost. Some of these, based upon correct mechanical principles and contemplating the use of none but suitable materials, are unquestionably fire-proof in the broad sense in which the term is now used, and deserve to be recognized and ranked according to their merits. Tests of these systems have in some cases been made, but generally by interested parties, under different conditions, and with the details of the construction not quite as they would be in practice. The lack of exact knowledge respecting the various systems, and the desire to ascertain the relative efficiency and fire-proof qualities of each, have actuated the department of buildings of New York city to conduct a series of careful and exhaustive tests. Each system is subjected to a severe fire and water test under identical conditions. For this purpose suitable structures are erected, according to plans furnished by the department of buildings, by each party desiring to make a test.

The test structure is built of brick, and is 13 feet by 17 feet in plan, outside measurement. Within the structure, at a height of 14 feet above the ground level, is erected the iron work designed to support the floor-system to be tested. Steel I-beams 10 inches deep, 25 pounds per foot, and spaced 4 feet center to center, are framed into girders resting on the end walls. The distance between the supports of the iron beams is 16 feet. The exterior walls are 13 inches thick, and are reinforced by buttresses or supported by suitable iron work, to prevent excessive cracking and bulging. At a height of about three feet above the ground level is constructed the main grate, which occupies the entire area of the building. This grate is in three sections, supported by two brick walls 13 inches thick, extending from end to end of the structure. In the three spaces between these two walls and the sides of the building, and about two feet below the main grate, are erected secondary grates. The fuel for the secondary grates is fed through three openings at each end of the structure, while that for the main grate is delivered through openings corresponding to a door at one end and a window at one side. The floor-construction to be tested is erected between the steel I-beams, thus forming three arches or spans of 4 feet each, and corresponding to the roof of the structure. Over the middle span and occupying an area of 4 feet by 16 feet is distributed the safe load of the iron beams, as fixed by the department of buildings, consisting of 150 pounds per square foot. In each of the four corners of the floor, openings are provided about twelve inches square, over which chimneys are built to a height of about six feet, to afford the required draught. A flat plastered ceiling is made under two of the floor arches or spans, the third being unplastered and presenting the naked surface of the fire-proofing to the direct action of the flames. The draught is regulated by sheet-iron doors swinging on hinges at the various openings, and also by sheet-iron dampers on top of the chimneys. Dry, hard cordwood to the depth of 2 feet is piled over the entire area of the main grate, and enough kindling wood is placed on the secondary grates to ignite the fuel above. After the fires are started, fuel is added from time to time, and the draught so regulated that a high and uniform temperature may be maintained. The temperatures are indicated and recorded by a Uehling, Steinbart & Co. pneumatic pyrometer. After the fire test has been conducted for a period of about five hours, the flames are extinguished, and actual water effects are secured with the regulation hose and fire engine of the New York fire department. The fire stream is directed for fifteen minutes against the under side of the floor and the interior of the structure, after which the floor is flooded on top to a depth of six inches. The stream is then directed against the grates for two minutes, which concludes the water test. After the building has cooled off, the deflection of the floor is ascertained, and a test-load of 600 pounds per square foot is substituted for the safe load on the middle arch. This load is applied to ascertain whether or not such a floor in a real building would require renewal after equally severe subjection to fire and water. The floor, or a portion of it, is finally tested to destruction to ascertain its ultimate strength. The purpose of the fire on the secondary or lower grate is to heat the ingoing air, and thus produce a higher final temperature in the interior of the structure than would ordinarily be obtained. All tests are made about one month after the floors have been erected.

The tests already made, with a brief description of each system, follow in regular order :

I. The Roebling System, September 3, 1896.

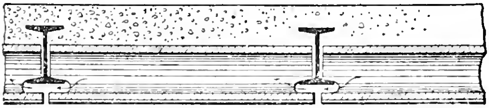
This floor consists of a wire-cloth arch, stiffened by woven-in steel rods or ribs ; the arch is sprung between the I-beams, and abuts into the seat formed by the web and the lower flange of the beams. On this



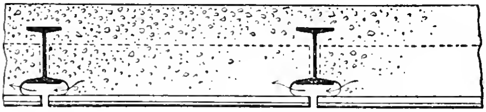
ROEBLING SYSTEM.

wire arch, which serves as centering, was deposited concrete consisting of 1 part of Aalborg Portland cement, 2 parts of sand, and 5 parts of steam ashes. The concrete was leveled flush with the I-beams, producing an arch having haunches about 9 inches deep, and a crown 3 inches thick at the middle of the span. Nailing sleepers, 2 by 3 inches, were laid crosswise over the tops of the iron beams at intervals of about 16 inches, and concrete, composed of 1 part of Portland cement, 2 parts of sand, and 10 parts of steam ashes, was filled between them to a depth of 2 inches. The flat-ceiling construction under two of the floor arches consisted of $\frac{5}{16}$ round iron supporting rods, attached by 1-inch offset clips to the lower flanges of the I-beams. Stiffened wire lathing was laced to these supporting rods, to which was applied machine-mixed mortar gaged with plaster of Paris. There was an air space, averaging about 4 inches in depth, between the flat ceiling and the floor arches.

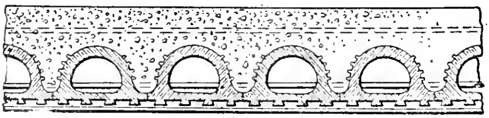
Details of Test. Duration of fire test, 11.10 A.M. to 12.58 P.M. Temperature: 12.01 P.M., 2,000 degrees F.; 12.10 P.M., 2,150 degrees; 12.10 to 12.45 P.M., 2,150 to 2,400 degrees. At the conclusion of the fire test the plastered ceiling and exposed concrete arch were red-hot. A portion of the brown coat of the plaster, 2 by 3 feet, had fallen away from the ceiling. After the water test half of the plaster was washed off of the ceiling, leaving the wire netting exposed at some places. The concrete floor arches, including the one exposed, were intact and uninjured. The final deflection of the I-beams, after cooling and removing load, was imperceptible. This floor was removed without further testing, and replaced by another for test No. V.



Longitudinal section through Lintel and Concrete.



Longitudinal section through Concrete.



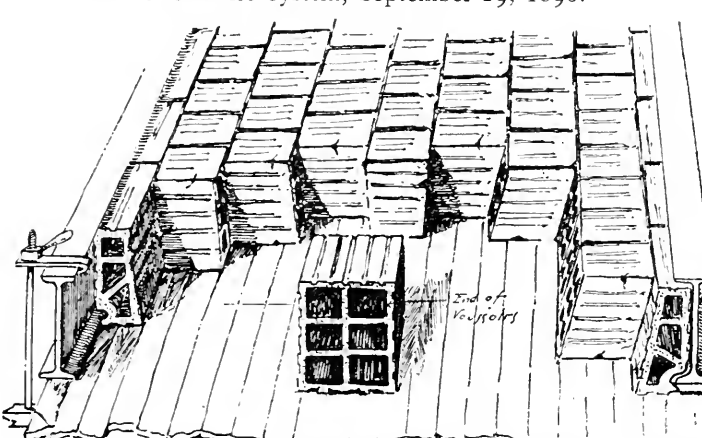
Transverse section through Lintel and Concrete Filling.
FAWCETT VENTILATED CONSTRUCTION.

II. The Fawcett Ventilated System, September 10, 1896.

This floor consists of hollow terra cotta lintels about 6 inches wide on the flat side (which constitutes the surface to receive the plaster for the ceiling) and about 2 feet long. On the upper side the lintel presents a cylindrical surface. In a cross section the hollow space is approximately circular in form, and about 4 inches in diameter. The ends of these lintels are designed to receive the lower flange of the I- beams, and be supported by them in such a manner that the flat sides of the lintels will be about 2 inches below the I-beams. The hollow spaces in the lintels thus constitute a connected air space about the lower flange of the I-beams. Ordinary lime plaster was used, the flat side of the lintels being provided with dovetails to receive and retain it. This system of construction requires that the I-beams be spaced at intervals of 2 feet. Six-inch I-beams so spaced, representing an equivalent carrying capacity, were substituted for the 10-inch beams, and rested directly on the end walls without framing as in the other tests. Concrete, consisting of 1 part of Atlas Portland cement, and 5 parts of steam ashes, was filled in above the lintels to a level of 2 inches above the I-beams.

Details of Test. Duration of fire test, 9.33 A.M. to 12.20 P.M. Temperature: 10.30 P.M., 1,850 degrees; 10.50 A.M., 2,200 degrees; after 11.20, large cracks had formed in the walls, and it was impossible to produce temperatures above 1,850 degrees. At the conclusion of the fire test the floor had deflected considerably, and the undersides of the tile lintels were red-hot. After the water test, the lintels had cracked off and fallen away over an area of about 20 square feet, exposing the concrete filling above. The plaster was off over the greater portion of ceiling. The following day the floor successfully supported the test load of 600 pounds per square foot. Final deflection of floor, considerable. The ultimate strength test was not made. The test structure has been torn down.

III. The Hollow Tile System, September 29, 1896.



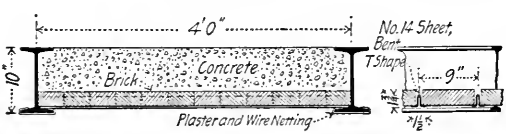
HOLLOW TILE SYSTEM.

Showing Method of Laying.

The floor for this test consisted of Raritan, end construction, porous terra cotta, cellular blocks, 10 inches deep. These were built in between the I-beams in the form of a flat arch, the under surface of the arch being depressed 1 inch below the I-beams. The skew backs were each provided with an angle projecting under the I-beams, adjacent blocks along the same beam forming a dovetail which supported a soffit tile about one inch in thickness for protecting the under side of the I-beam. The blocks were about a foot square, with a special key for the center. They were laid in cement mortar, consisting of 1 part of Dyckerhoff Portland cement to 1 part of sand. Nailing sleepers, 2 by 3 inches, were laid over the I-beams, and concrete, consisting of 1 part of Dyckerhoff cement, 3 parts of sand, and 5 parts of steam ashes, was rammed in above the hollow tile blocks to a depth of 3 inches and levelled flush with the tops of the nailing sleepers. A thin coat of machine-mixed mortar was applied to the under side of two of the arches.

Details of Test. Duration of fire test, 9 A.M. to 3 P.M. Owing to difficulty in securing the necessary steam pressure and the absence of the assistant in charge of the pyrometer, no actual temperatures were recorded. Copper wires coiled around iron bars were inserted through openings in the walls occasionally, and were fused. This indicated a temperature of 2,000 degrees, approximately. At the conclusion of the fire test the under side of the floor was red-hot, and some of the plaster had fallen off. After the water test it was observed that the lower portions of the tile blocks, over an area of about 25 square feet, had broken away under the action of the fire stream, exposing the cellular spaces. The floor subsequently successfully withstood a test load largely in excess of 600 pounds per square foot. Final deflection, apparent. The ultimate strength test was not made. The test structure has been torn down.

IV. The Rapp System, October 26, 1896.



RAPP SYSTEM.

This floor consists of a layer of common bricks laid flat side down and supported by a series of light T-shape irons made of No. 14 sheet iron. These Ts are cut in lengths to fit at right angles between the I-beams, the flat side of the Ts resting on the lower flanges of the beams. The Ts are held in position, nine inches apart, by light iron spacers. Concrete, consisting of 1 part of Dyckerhoff Portland cement and 8 parts of steam ashes, was filled in above the layer of brick and leveled flush with the top of the nailing sleepers, 2 inches above the I-beams. The under flanges of the beams were covered with wire lathing, and a thin coat of ordinary plaster was applied to the whole of the under side of this floor.

Details of Test. Duration of fire test, 10 A.M. to 3 P.M. Temperature at 11 A.M., 1,800 degrees. About an hour after the fire was started a piece of plaster falling from the ceiling disabled the pyrometer. Subsequent temperatures were indicated approximately by the fusing of copper wire. At the conclusion of the fire test the greater portion of the plaster had fallen away, and the under side of the floor was red-hot. Some of the light Ts supporting the brick had sagged down somewhat. After the water test, it was found that the fire stream had dislodged a number of the brick in the middle portion of the ceiling, exposing the cement filling above over an area of about 20 square feet. This floor later sustained the 600-pound test load successfully. Final deflection, imperceptible. Ultimate strength test to be made later. Test structure still standing.

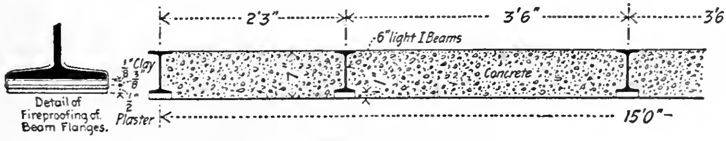
V. The Roebling System. Second Test.

The construction in this test was identical with that of Test I.

Details of Test. Duration of fire test, 10.06 A. M. to 3.06 P. M. Temperature: 11.30 A. M., 1,800 degrees; 12 M., 2,000 degrees; 12.43 P. M., 2,300 degrees. After 12.45 P. M. a uniform temperature between 2,000 and 2,200 degrees was maintained to the end. At the conclusion of the fire test the false-work and plaster had fallen down, the floor had deflected perceptibly, and the wire centering and the under side of the floor arches were red-hot. After the water test the floor arches were found to be apparently uninjured. The fire stream loosened a couple of the ribs of the wire centering, but had little or no effect on the floor arches. The following day the test load of 600 pounds per square foot was applied without any indication of failure. Final deflection, apparent. Ultimate strength test to be made later. Test structure still standing.

VI. Thompson System, November 7, 1896.

This floor consists of a solid monolith of concrete, spanning the



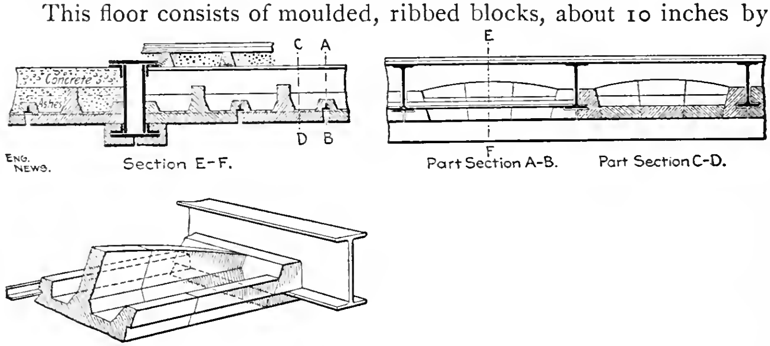
THOMPSON SYSTEM.

interval between the I-beams and projecting 1 inch below them. The iron work in this case consisted of I-beams 6 inches deep and weighing 13 pounds per foot. These were spaced about 3 feet 6 inches, center to center, and were framed into a girder resting on the side walls of the structure, having a clear span of 12 feet. The concrete was composed of 1 part of Dyckerhoff Portland cement, 2½ parts of sand, and 6 parts of steam ashes. To this mixture was added, during manipulation, certain proportions of two other substances, the composition of which the patentees desire for the present to be withheld from publication. The under side of the iron beams was protected by a thin layer of a special compound designed to be a non-conductor of heat, which was held in position by wire lathing. Nailing sleepers, 1⅛ × 4 inches, were laid flat side down over the beams, and a low grade concrete filled between them, flush with the tops. Several different varieties of plaster were applied in sections to the under side of this floor.

Details of Test. Duration of fire test, 10 A. M. to 3 P. M. A temperature of 2,000 degrees was obtained about an hour after the fire was started. During the remainder of the test, the temperature varied from 2,000 to 2,300 degrees. At the conclusion of the fire test a large portion of the plaster had fallen away from the ceiling, and the under side of the floor was red-hot. After the water test the under side of the floor exhibited a slight depression, averaging about ¾ of an inch over about 10 square feet in the middle of the ceiling, where the fire stream had washed away a small quantity of the material. Final deflection after cooling, perceptible. The test load of 600 pounds per square foot was subsequently applied without any signs of failure. Ultimate strength test to take place later. Structure still standing.

VII. The McCabe System, November 9, 1896.

This floor consists of moulded, ribbed blocks, about 10 inches by



MC CABE SYSTEM.

2 feet in plan, built in the form of a flat arch between the I-beams. Small T-irons arranged at right angles to the beams at intervals of every two feet and resting flat side down on the lower flanges of the beams furnish the necessary supports during the erection of the arches,

and contribute to the strength of the floor. The blocks, consisting principally of a composition of plaster of Paris and steam ashes, are so designed that, when in position, their under surface is 2½ inches below the lower flanges of the I-beams. Steam ashes were filled in between the projecting ribs of these blocks, the surface finishing off in the form of an arch. On this filling was deposited concrete consisting of 1 part of Dyckerhoff Portland cement, 2 parts of sand, and 4 parts of steam ashes, the concrete being leveled flush with the tops of the I-beams. The usual 2″ × 3″ nailing sleepers were laid over the I-beams, and a low grade concrete was filled between them. Ordinary lime plaster was applied to the ceiling.

Details of Test. Duration of fire test, 10.00 A. M. to 3 P. M. Temperature at 11.20 A. M., 2,000°. After 11.20 A. M. until the end of the fire test a temperature above 2,000° was maintained, except for short intervals, while the fires were being replenished. At the conclusion of the fire test the ceiling was observed to be red-hot, some of the hard finish still clinging in shreds to it. After the water test the plaster and those portions of the plaster blocks projecting under the beams had fallen away. There were also a number of slight depressions in the under surface of the blocks wherever the fire stream had been allowed to play for any considerable period. At four or five places the plaster blocks were broken, and fragments had fallen away, exposing the concrete filling above. This floor sustained successfully the test load of 600 pounds per square foot. Final deflection, imperceptible. Ultimate strength test to be made later. Structure still standing.

The duration of the fire test in several of the earlier tests was not uniform, as it required more or less experimenting to establish a suitable period. A fire test of five hours, as finally adopted, together with the high and uniform temperatures produced, is probably more severe than that of an actual fire would ever be, except perhaps in warehouses for storing inflammable goods. The extreme tests are interesting, however, in that they bring out more distinctly the fire-resisting qualities of the different materials employed.

Other tests are to follow. A detailed discussion of the requirements of fire-proof construction and the relative efficiency and economy of the different systems will be given in a later paper.

NOTE.—We are indebted to *Engineering News* for the illustrations of the FAWCETT, RAPP, THOMPSON, and MCCABE constructions shown with this paper.

ENGLISH PRACTICE IN TRANSMITTING POWER IN MINES.

By a Staff Writer.

IT is only within comparatively recent years that very much attention has been given to the development of the underground machinery of mines. A main hoisting and pumping plant has always of course been a necessity, ever since there has been any deep mining by shaft, and very deep tunneling is a thing of modern date. The heavy surface plant has consequently been brought to an advanced stage of progress, and, while perhaps it may often look rough to those who are familiar with the machinery of factories only, it is on the whole very satisfactory, and in some directions, as in the case of the Cornish pumping engine and its connections, has reached a high degree of efficiency. But, in these days of sharp competition and increasing demand for rapid production, closer economies and better appliances are absolutely essential to profitable mining where the selling price of the product is low, as in the case of all coal and all iron ores, and indeed of the large majority of mineral products, for most of the mineral production now comes from ores which would have been considered very low-grade only a generation ago.

So in every department of mining great advances are being made,—because they have to be made,—and in none more than in the mechanical branch. Further, of mining machinery no division just now is of such interest as the underground plant, in which there are many improvements which are rendered possible only by the general progress in mechanical engineering in all directions.

Mining men all over the world should feel greatly indebted to Mr. Rankin Kennedy for his very able series of papers, recently given to the profession, on the transmission of power in mines.* Although Mr. Kennedy confines the discussion to British mines, and of these mainly to the collieries, principles are universal, and it is not difficult to see how the application must be varied according to conditions elsewhere.

Before going further, it must be said that no one who reads this memoir in full in the original can fail to be impressed with the conscientious attempt at impartiality with which the author handles questions which are the subject of somewhat acrimonious controversy between the

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*"Transmission of Power in Mines." London *Electrical Review* for Aug. 7, Aug. 28, Sept. 4, and Sept. 11, 1896.

advocates of different systems and the makers of rival types of machinery. This is especially noticeable because the essay appears in a class journal and comes first under the notice of electricians, for whose benefit it is particularly intended. The *Electrical Review* is to be congratulated on obtaining for its readers a really fair summary of the situation from the point of view of one who, on the whole, favors electricity. Much harm has been done by the too frequent habit some people have of "claiming the earth" for electricity, or, as Mr. Kennedy puts it, asserting "the superiority of electricity over everything else," where it would be more instructive to compare it with other agents applied to the same purposes. He goes on to say that, in comparing these agencies for the various operations required in mining, it will be seen in what cases electricity is superior, and why it is so, and observes that it is necessary for electrical engineers to keep an eye on rival agencies and to investigate the possibilities of compressed air at its best.

The author, it may be remarked, considers only three competitors, —steam, compressed air, and electricity; and of these he limits the utility of steam pretty closely. There is however one other rival in the field,—hydraulic power, as applied in driving pumps in some European mines and in a few notable installations in the United States, the power water being supplied under great pressure, taken down the shaft to the hydraulic pumps in one pipe, and brought up in another or through a tunnel, thus securing a difference of head, the whole arrangement being a reversal of the principle of the hydraulic ram. Perhaps rope and rod transmission should also come into the comparison, for, although driven by steam or water and only transmitters, so also are electricity and compressed air only transmitters.

As a prime mover steam stands alone at the British collieries, and, if not applied direct, is the source of the other agencies. The author, in limiting his field to one set of mines, has omitted one of the great advantages of electricity in other places where water power is available, cheap, and sometimes even free, admitting of an installation of Pelton impact wheels or turbines at small cost, to run the generators, the power plant often being several miles from the mine and thousands of feet below it. There are a few examples of the use of water direct, to pump and hoist, as in some California mines, but these are exceptional. There is also a limited field, in certain localities, for the windmill as a source of power for generating electricity. But neither water or wind power are available at the British mines. Here is Mr. Kennedy's general comparison of the three agencies to which he limits the discussion:

"Steam differs from the other agents, as it is the direct product of the natural elements,—water, air, and fuel. The energy, or at least a small part of the energy given off by the combustion of the fuel, is stored up in the water in a boiler; this energy converts the water into steam, and the energy is indicated by a pressure; this energy is converted into power by the steam engine.

"Compressed air cannot be directly obtained from the combination of elements; it must be compressed by some power generated and applied to the compressor. Compressed air acts only as a carrier of the power from the steam engine, waterfall, or windmill, to the place where the work is to be done.

"Electricity can be generated directly by the combination of natural elements on a small scale in the apparatus known as a primary battery, but at present this method is so expensive and troublesome that its use is confined solely to very light work, such as ringing bells and working telegraphs. Wherever any considerable power is required, we must get our electrical energy, as we get compressed air, from a machine driven by a prime mover, such as steam. Steam being the prime mover in all three systems, it is not possible, in making comparisons, to set steam aside. We can compare compressed air and electricity as transmitters and distributors of power, for both are alike in being merely carriers of energy, exactly as ropes or belts might be compared for the purpose of transmission of power; but, in all cases in mining work, steam power is the origin of the compressed air and electricity.

"We may compare the three systems from two points: first, the efficiency of the transmission, and, secondly, the efficiency of the conversion into work. We may then compare them for the purpose of ascertaining their relative convenience and adaptability. This latter point of view may be the most important in underground working, although efficiency is now more generally recognized as essential in colliery working than it used to be; some people argue that, as coal is very cheap at the pit, efficiency in power appliances is of little consequence; but that is now regarded by most colliery owners as a dangerous conclusion, and efficiency is insisted upon in most cases."

The purposes for which power is required underground are stated as haulage, coal-cutting, drilling rock, and pumping. To these might be added winze hoisting, lighting, signalling, and blast-firing—though the latter is done by small portable machines, and not, we believe, by taking current from the electric conductors.

The author considers that the use of steam below-ground can be seriously considered in only two cases: (1) where it is led below to the haulage engine placed near the bottom of the shaft, and (2) for steam pumps when similarly located. Here the chief difficulty arises from the great length of steam pipe and consequent condensation. In another connection he notes the objectionable heat from the pipes and engines, which would preclude steam below-ground in some hot mining districts,—like the Comstock, for instance,—but which is not so important a matter in the English mines, except that in dry collieries it has a tendency to raise coal dust

All the British collieries are fitted out with steam engines for hoisting, to begin with; then, as the workings extend, underground haulage by steam (with different methods of traction by wire rope, chains, etc.), so that compressed air or electricity must be adopted for rapid and economical traffic, though Mr. Kennedy seems to forget that slope mines and some shaft mines have the haulage engines at the surface. Pumping is often or usually necessary, and is sometimes very heavy. There are also requirements for power at the surface for the machine shop, coal screening and washing machinery, and transportation. The author follows Mr. Foster Brown in rating the steam engines used for these purposes in Great Britain as of low efficiency, using, say, not less than 8 pounds of coal per h. p. hour,—that is, not only for the steam used in actual work, but counting also that wasted by condensation, leakage, and fall in pressure in surface pipes; so that Mr. Kennedy considers this figure too small, when long pipes are taken underground for pumping or haulage, and says that 10 pounds per h. p. hour would be nearer the truth, meaning this as an average for all the mines. Now, while coal is very cheap at the collieries,—and we suppose that in English practice a good deal of unmarketable coal is utilized in this way,—the high losses show very plainly why steam is an expensive agency underground, and also the need for something better. A correspondent of the *Electrical Review*, commenting on this point, calls attention to the fact that at several large collieries the boiler furnaces are heated by coke-oven gas. This would effect a large saving, as the fuel so used is a waste product, costing nothing.

As to the working of hoisting engines by electricity, Mr. Kennedy admits frankly that the electric motor is not an economical machine for working under the conditions of constantly starting and stopping, it being essentially a constant speed machine, if high efficiency is required. Every time it starts, which may be twenty or more times an hour, power is lost in overcoming inertia and getting up speed, which may take 20 seconds with a large motor. An analogy is drawn between the electromotor and the turbine, which it much resembles in this respect, for, if we jam up either so that it cannot move, a great stream of water or current of electricity, as the case may be, will run through without doing any work; whereas a compressed air or steam engine wastes no fluid at all in starting, for, unless the piston moves, no fluid escapes. This is a small matter with electromotors running for hours at a time, but in a motor running only a couple of minutes or so, and starting twenty times an hour, it amounts to a great deal. Here it may be remarked that drills and coal cutters are also intermittent in action. Mr. Kennedy states that during the time from no speed to full speed the work done by an electromotor is only a fraction of the power applied; he places the loss at from 50 to often 70 per cent. Of course, as steam has to be used anyhow at the British collieries, and the boilers can be placed near the engines, there would be no reason for using anything else for hoisting, and, we may add, for operating a system of Cornish pumps. For all other purposes electricity or compressed air can, Mr. Kennedy asserts, be used to advantage. It is therefore a question of the comparative advantages or disadvantages of these two carriers of power. The case is very different in many of our western mining districts, where, because of the high cost of fuel, or absence of fuel, and availability of water power, electricity is used for everything, including hoisting; but there it is hardly a matter of choice.

Mr. Kennedy divides the treatment of the problem of power underground in collieries into: (1) the transmission of power in mines free from gas, and (2) in mines considered dangerous from the presence of explosive gases, so that in the first case we are at liberty to select a system quite different from and altogether inadmissible in the other case; and we think it may be well to interpolate the suggestion that it is not always easy to draw the line between fiery and non-fiery coal mines, since all are gaseous to some extent. But the author, an experienced engineer, recognizes that safety is the first consideration in mining, and explains that the application of electricity in fiery mines has been very cautiously approached. The danger is that of sparking at the brushes on the motors, and that of rupture or contacts made in the cables and switches. It is claimed that no accidents have occurred from sparking at the brushes, but this, Mr. Kennedy says, is no doubt due to the extreme caution of owners of fiery mines. He does not seem to think much of the "lame devices" for preventing sparking, and says that it is a foregone conclusion that motors with commutators and brushes will never succeed in dangerous places, but thinks favorably of the polyphase motor, which promises to get over the difficulty, having neither commutators or brushes. As to the wiring, he states that in a fiery mine it costs more than twice as much as in a non-fiery one, for all wires require to be buried and all switches to be inclosed in gas-tight iron cases.

Compressed air has the advantage that it can be used with safety anywhere, but it is pointed out that unfortunately the most important improvement—that of reheating—cannot be applied in presence of gas.

The compressed-air systems have not stood still; improvements in compressors, pipe lines, and motors have been very great, so that for efficiency, it is admitted by Mr. Kennedy, it "runs electricity very close for long-distance transmission." He also notices the aid to ventilation given by the exhaust, but says that in collieries too much stress must not be laid on this, for efficient ventilation has to be provided for in any case. We might add, however, that in many metal mines in this country the exhaust from the air drills is the only artificial means of ventilation.

For obtaining isothermal compression the author does not believe in water jackets on the compressors or in water pistons, but prefers jet injection into the cylinder during compression. "The best method . . . is to use a compound compressor to carry out the work in stages, cooling the air to atmospheric temperature in intercoolers between each stage of the compression;" and "for mining purposes low pressures are desirable, especially in coal-cutting machinery [and rock drills], where flexible pipes are used, but, even if the pressure is only 50 to 60 pounds, compound compressors are an advantage." As to compression in stages, putting engines and air pumps on same bed, and development of mechanical details, like valves, the fitting of compressor pistons, etc., we think some credit should be given to American designers, who have taken the lead. As to efficiency, the following comparisons are made:

"By adopting compound compressors of recent designs with all the latest improvements, the cubic feet of air compressed per hour per horse power has been raised from 264 to 367, a most decided advance, and power can be transmitted at a pressure of 60 pounds to two miles, distance without reheating at the motor with an efficiency of 50 per cent. on the indicated horse-power of the compressor engines; by reheating the air at the motors this efficiency rises to 70 per cent., which is a very good result, and is all the more significant from the fact that the compressed-air generator has the advantage over the electric generator, inasmuch as it can be run all the time at full load, owing to the ease with which air may be stored. The efficiency of compressed air, taking the brake horse-power of the compressors and the brake horse-power of the motor, is, with all improvements, 65 per cent.

"Compared with electricity, we may take the engine at 90 per cent. and the dynamo to average 85 per cent.; as in transmission plants the load varies considerably and is never long at a time full, we get $0.76 = 76$ per cent. efficiency at the best for the dynamo and engine. At full load we might get 93 per cent. for the dynamo and

90 per cent. for engine, giving 84 per cent. efficiency,—an efficiency actually obtained in some carefully-prepared full-load tests. We may make the efficiency of the conductor 95 per cent., and, taking the motor to average 90 per cent., we get a total efficiency of 71 per cent. for electricity, compared with 70 per cent. for compressed air reheated; such a result for air can only be obtained by expensive and considerably more complicated machinery than is the case with the electric plant. Nevertheless, we must admit that compressed air has made up in efficiency close enough to electric transmission to leave little room for choice between the two under that head. In a fiery mine a commutatorless motor would give an efficiency of 70 per cent., while the air motor due to the prohibition of reheating would only give 50 per cent. efficiency; it is only in safe mines, where reheating could be allowed, that the 70 per cent. efficiency can be obtained by air."

The cost of air pipes as compared with electric conductors, on points of first cost and maintenance, power for power, and for the same distance, is placed at 8:1 in a non-fiery mine and 4:1 in a fiery one. As to the air-power motors which are to do the work, not much is said, since they resemble steam engines so closely, except that the air is used with less expansion unless reheated. The great economy of reheat ing is shown by the fact that 15 pounds of coke per hour will reheat enough air for 80 h. p.

Mining engineers, as Mr. Kennedy remarks, are, as a rule, quite able to pass judgment on the engines, compressors, pipes, and air motors; but not many of them are able to see the good or bad points in electrical machinery. He goes into considerable detail as to the different types of dynamos and alternators, for which we must refer the reader to the original article. The author's judgment is that of the three types, single bobbin, bipolar, and multipolar, the first is good only for small sizes, the second being better up to 300 volts, and the multipolar best above 300 volts; he evidently prefers the multipolar in all cases. If over 300 volts is used, very careful insulation and wiring must be employed, though most persons could stand a shock of 500 volts and recover. As to the choice of continuous or alternating systems and two phase or three-phase generators, and, in fact, all points of importance, we cannot do better than quote the author's general maxim that mine managers should consult an independent electrical engineer when about to order a plant. There is also another very good general rule,—that cheapness in first cost is not always economy.

Passing now to matters of installation which do not require expert electrical knowledge, Mr. Kennedy's remarks about wiring are that, in non-fiery mines, the electrical cables, switches, and motors may be of the ordinary kind, and run without any special precautions,—ordinary 1,000-megohm rubber-insulated cable carried on porcelain insulators from the generator to the shaft, and hung on insulators down the shaft, with a protecting board fixed in front all the way down. Sometimes a pipe is fixed, and the wires run through that in the shaft. If the mine is dry, wood casing may be used below, but in non-fiery mines a good deal of liberty may be allowed in running wires, protection from personal contact with the conductors and from earth contacts being the only imperative requirements.

As to electrical coal-cutting machines, and for that matter all coal-cutting machinery, they do not make as much progress as might be expected. As Mr. Kennedy says, their chief advantage is not so much that the coal is got a little more cheaply, but that it is got without so much smashing and waste. Omitting the diamond prospecting drill, there are two kinds which are driven by electricity,—the auger drill for coal and soft rock, and the percussion drill. As to the latter, our American makes of air drills leave little to be desired, but Mr. Kennedy says that a good electric percussion drill is yet to be invented.

In fiery mines the use of electricity presents problems in everything; the wires, switches, and motors are required to be absolutely free from the possibility of sparking, and the utmost care in laying the wires should be required. The author gives his opinion as to the precautions to be taken, and describes some of the details. His final summing up of the case is, on the whole, strongly in favor of electricity, subject to conditions already noted. He says:

"In the non-fiery mine electrical transmission is cheaper in first cost and in maintenance, much easier applied, and higher in efficiency, than compressed air. In the fiery mine it is much more efficient, and with induction motors quite as safe, although difference in first cost is not so great."

The advocates of other agencies will, of course, take exception to this dictum, but, in justice to Mr. Kennedy, it should be stated that, to follow his closely-written descriptions and argument, his notable essay should be read in its entirety, for it is impossible in a review of moderate length to even mention all, or even a majority, of the points he raises.

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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American Architect, The *w.* $6. Boston.
Am. Chemical Journal. *b-m.* $4. Baltimore.
American Electrician. *m.* $1 New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Architect, The. *w.* 26s. London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30s. Sydney.
Bankers' Magazine. *m* $5. New York.
Bankers' Magazine. *m.* 18s. London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23s. 8d. London.
Builder, The. *w.* 26s. London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
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Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Plant. *m.* 6s. London.

Electrical Review. *w.* 21s. 8d. London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6d. London.
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Engineers' Gazette. *m.* 8s London.
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Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
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Foundry, The. *m.* $1. Detroit.
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Gas Engineers' Mag. *m.* 6s. 6d. Birmingham.
Gas World, The. *w.* 13s. London.
Gunton's Magazine. *m.* $2. New York.
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Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4d. London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6d. London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8d. London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver.
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8s. London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
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Plumber and Decorator. *m.* 6s. 6d. London.
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Power. *m.* $1. New York.
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Progressive Age. *s-m.* $3. New York.
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Scribner's Magazine. *m.* $3. New York.
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Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
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Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
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Technology Quarterly. $3. Boston.
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Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
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Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

A Notable Heating Apparatus.

THE illustration herewith presented, together with a description condensed from *The Engineer* (London, Oct. 16), shows how the utilization of exhaust steam for heating may be carried out in a system of hot-water pipes of a bore generally considered much too small for such a purpose. It is an interesting example of how the knowledge of principles enables the engineer to surmount what at first seem insurmountable obstacles.

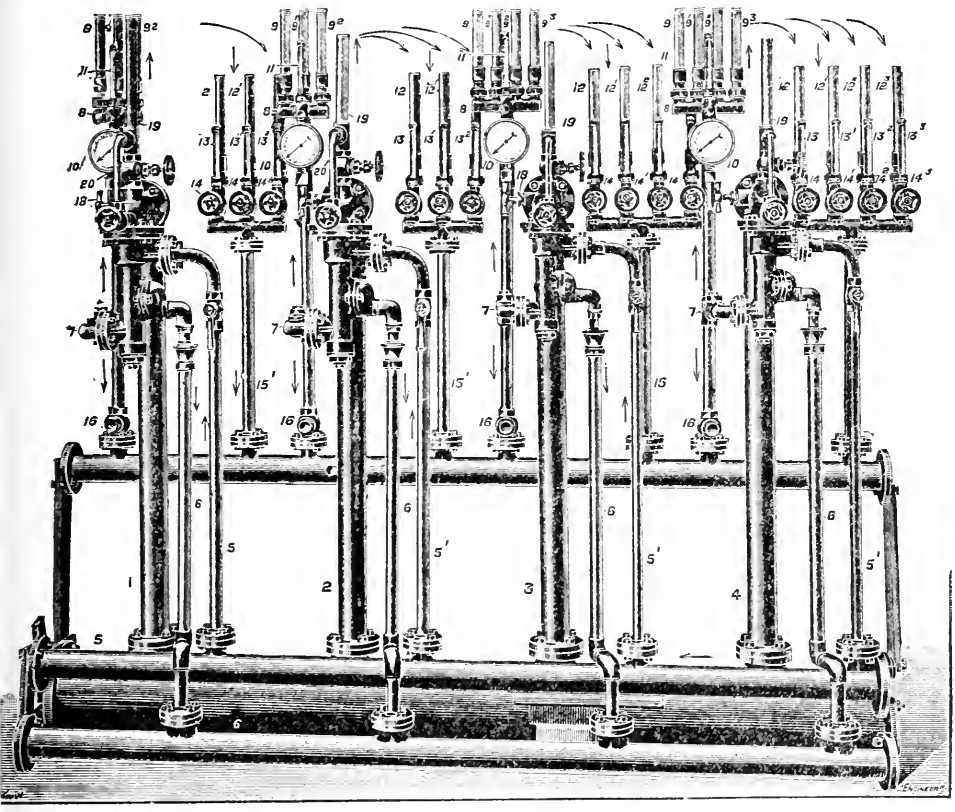
The head post-office at Manchester having been equipped with an electric plant, it was found that this necessitated the removal of the high-pressure heating apparatus in the basement, in order to make room for the boilers of the electric plant. It was desired to utilize the exhaust steam from the dynamo engines for heating, but at first it seemed necessary to remove all the piping hitherto employed, in order to carry out this desire. The building has in it twenty-four thousand feet of pipe, a large part of which is about what, in America, would be called ¾-inch pipe, and to remove and replace it by larger pipe adapted to exhaust steam heating in the ordinary way would have entailed a costly operation. In this dilemma Mr. J. W. Curra, an engineer of the post-office staff, bethought him of a method for using exhaust steam injectors without replacing the existing pipes. An experiment having established the feasibility of the plan, it was carried out as herein described and illustrated.

First of all, the twenty-four thousand feet of piping was divided up into twenty-eight separate circulating systems, sixteen for the offices on the ground floor and twelve for the instrument room on the second floor; experiments, however, showed it to be desirable to reduce the number of these systems to fourteen. Simple exhaust steam injectors were tried, but experiment led to the substitution of combined live steam and exhaust injectors, as the supply of exhaust steam might not at all times be available.

Four injectors are used for heating the circulating water, two being connected to the instrument-room circulations, and two to those serving the sorting-office and adjoining rooms. These injectors will together circulate through the pipes a total of 2,000 gallons of water per hour, at an initial temperature of about 200 deg. F., when using exhaust steam alone. They are connected above to the live steam pipes and the circulating heating pipes, and below to the main exhaust steam pipe from the electric lighting and pneumatic service engines, suction and discharge water pipes, and waste pipes. The heated water, after being passed through the circulating pipes, is returned by means of the common discharge pipe to a large cooling tank, forty-five feet long, placed in one of the open areas against the street, which cools the water so that it can be again taken up by the injectors and thus kept constantly circulating without waste, it being impracticable in this instance to take the boiler feed water from the heater.

Each injector is provided with a pressure gage and thermometer between its delivery outlet and the distribution boxes to which the circulating pipes are attached, and a weighted bye-pass valve is also fitted, which will pass a part or all the water delivered at once to the common discharge pipe, if circulation through the heating pipes is retarded or stopped. Each circulating pipe at its discharging end is provided likewise with a thermometer and a hand-wheel screw-down valve. The nicety with which temperature and flow can be regulated by means of these devices is considered a special feature of the system. The compactness of the arrangement will also be admired by heating engineers.

Exhaust steam is supplied to the injectors by branch pipes 1, 2, 3, and 4, leading off from the main exhaust pipe from the electric light and pneumatic engines. 5 is the main water-supply pipes, and 5^1 the branches from it to the various injectors. 6 is the main overflow pipe, and 6^1 the four branches. The injectors deliver through the back pressure valves and pipes 7 into distribution boxes 8, whence the hot water is distributed into the flow pipes 9, 9^1, 9^2, &c., of the various circuits. The pressure gages 10 show the frictional resistance in the circuit pipes, and the ther- of each circuit, and consequently of each room, throughout the building B, is under positive control, and capable of instant variation. The return water enters the pipe 15 by means of the branches 15^1, and passes on into a large tank, through which, after having quietly circulated and cooled down, it returns to the injectors again through the pipe 5. In case the various valves are so closed that the water delivered from the injector cannot get through, weighted bye-



HEATING APPARATUS, MANCHESTER HEAD POST-OFFICE.

mometers 11 the temperature of the water as it enters the pipes. 12, 12^1, 12^2, &c., are the return ends of the various circuits 9, 9^1, &c.; and the thermometers 13, 13^1, 13^2, &c., show the temperature at which the water leaves the pipes, this temperature, or, in other words, the amount of hot water passing through each pipe, being regulated as required by means of the valves 14, 14^1, 14^2, &c. By means of these thermometers and valves the temperature pass valves 16 are provided to enable a part or the whole of the delivery to "short circuit" into the return pipe 15; 18 is the wing valves controlling the exhaust steam; 19 a steam pipe and valve to work the injector by ordinary live steam in case the engines are not working; and 20 valves, supplying a small live steam jet sometimes placed, as in the present case, in the injector to give additional force to the injector when such is required. If required, the injectors may also be employed for feeding the boilers direct as well as supplying the heating pipes.

The Heating Plant of The University Building, New York.

THE one-pipe system of steam-heating is a system wherein the water of condensation is returned from radiators or coils by gravity through the same pipes that supply the steam. The two-pipe system is one in which the water from steam condensed in the radiators is returned to the boiler through separate pipes. In the latter system each radiator has an inlet for steam and an outlet for water to which, respectively, the steam and return pipes are fitted. In the one-pipe system the steam-supply pipe is screwed into a single inlet which, while admitting steam, also serves as an outlet for the water, which flows along the bottom of the horizontal connection back to the steam riser pipe, falls through it to the steam main at the bottom of the riser, and thence flows along the bottom of the main back to the boiler.

The one-pipe system has been more extensively used in the western than in the eastern part of the United States, and, in buildings of moderate size, has proved very successful when skill and good judgment have been used in its installation. So far as we know, the building named in the title of this review is among the first, perhaps the first, to apply the system to the heating of tall buildings.

Our excellent contemporary, *The Engineering Record* (Sept. 19), gives an illustrated description of this installation, the main features of which are as follows:

The exigencies of the building, it appears, demanded the use of both the two-pipe and the one-pipe systems, in order to meet the desired requirements as far as possible. The building is one hundred by one hundred and seven feet in plan, and is eleven stories high. The first seven stories are heated by the two-pipe system, while the four upper stories are heated by the one-pipe system. The arrangement well illustrates the fact that nearly every heating installation has peculiar conditions, which must be met in the design of the apparatus, and the consequent fact that rule and precedent can guide the designer only in such features as are ordinarily met with. Beyond this he must rely upon his knowledge of principles.

As the eighth and ninth stories are used as lofts,—a large printing establishment occupying the basement and the first stories,—and as the tenth floor is to be occupied by a law school, while the upper part is to be divided into artists' studios, it will be seen that three general sets of conditions are presented in one and the same building,—to wit, a manufacturing establishment, a school, and a series of comparatively small rooms. Heating engineers will readily appreciate the difficulty in working out a design that will entirely and satisfactorily meet these several requirements simultaneously.

Another peculiarity of the building is that above the seventh floor, which supports the large printing presses, the walls of the building are materially thinner, and their lines change. While wall coils are used below the eighth floor, the law school and the studios are heated partly by radiators and partly by coils. Here is enough to render both design and satisfactory execution more than ordinarily difficult, but the adoption of the two separate systems opens a path for the designer. The one-pipe system heats practically the two consecutive upper stories only, and the main difficulty in it is thus reduced to meeting different sets of conditions pertaining to the school and the studios.

The stories so heated are supplied by a six-inch pipe "which is carried through a pipe-shaft to the eleventh floor, where it divides into two branches, which nearly make the circuit of the floor," and from this risers are let down to the radiators on the tenth floor.

As much steam has to be supplied for power purposes, both the power plant and the heating plant working harmoniously, it will be understood that a good piece of engineering work was required in this installation. The special design will interest engineers. Our cotemporary does not state whether the results desired have been fully attained or not, but its detailed description and illustrations form an interesting study to heating engineers. The ventilation is effected by fans, etc., and other interesting points are worked out in the design, information upon which is supplied in the article thus briefly reviewed.

Self Helps.

ALL original art is intimately connected with the exercise of the power of imagination. The cultivation of the imagination and its severe discipline into artistic bounds are fundamental principles in art education. Architecture is an art, in the highest sense of the term. The supervising architect is called upon to exercise business qualities more than the painter or the sculptor; but, notwithstanding, his ability to conceive beautiful forms and to arrange these in groups pleasing to the eye must have been widened by study and the education of his imaginative power, which cannot be subordinated to business, if he would ever achieve anything great in his profession.

Mr. A. B. Bibb, in *The American Architect* (July 11) talks pleasantly and sensibly of self helps in the cultivation of the qualities essential to success in architecture. Among other things, he speaks of the books whose perusal will aid in cultivating the imagination, and thinks that books devoted to architecture, painting or sculpture should not alone be relied upon as aids to the development sought.

"We are too prone to be matter-of-fact, even at our best. The irksome requirements of actual practice tend so often to crush out the dreamier qualities which go with every flight of the imagination that, in the rush of business, we may forget the satisfaction and the real growth that might come to us by at times following the intellectual revelry of a work such as the 'Arabian Nights,' 'The Ancient Mariner,' Prescott's 'Conquest of Mexico,' or Rudyard Kipling's 'Jungle Stories.' Indeed, I know of no better literary antidote for architectural affectation than to travel with Mowgli through the romantic imagery of the jungle, letting our fancies run their own pace in a world which is new to us, leaving us with a clearer vision and a truer perception for the practical, tangible art with which we have to grapple. If I were obliged to choose between fiction and Viollet-le-Duc as a course of reading for an architect, my reason might carry me to the latter; but I firmly believe more growth would come in the long run from a little literary dissipation than from scientific indigestion." "Scientific indigestion" is a decidedly happy expression as characterizing the condition of a certain too numerous class of mental dyspeptics turned out under the cram principle of the modern system examinations. Carrying out the simile it may be added that it often relieves a tendency to such indigestion to fill the mental maw with food that requires little or no alteration to prepare it for assimilation, even if it lack nutriment.

Strength of Georgia Pine.

MR. HARRY H. MILES, in *The Southern Architect*, describes experiments made by him with a view to determine the strength of Georgia pine, a timber extensively used for building purposes. He found difficulty in holding his test pieces so that they would break through the smallest section, the gripping devices injuring the grain of the wood so much that breaking is apt to occur through the injured grain, instead of the test section. From this he concludes that, when this timber is used for tie rods, etc., the estimate of its strength should be made from strain required to pull out the fastenings, from the shearing or splitting of the wood, etc., and not from the tensile strength of the solid pieces.

The strength of the timber depends upon the degree of seasoning, the part of the tree from which the test piece is taken, and the position of the grain in relation to the direction in which the strain is applied.

From twelve tests of "green timber taken from all parts of a tree, an average modulus of rupture of 9,313 pounds per square inch was determined. Seven tests of seasoned timber gave an average modulus of rupture of 10,524 pounds per square inch, showing that seasoning adds about thirteen per cent. to the strength of the green timber. The strongest timber is in the butts of the trees, and the heart is stronger than the sap-wood in all parts."

A discrepancy between the modulus of rupture and the tensile strength of the material (the average tensile strength being 15,217 pounds per square inch, while the modulus of rupture is 9,786 pounds) is thus explained.

"When a beam is subjected to a transverse load, the part of the beam on the side next the load is subjected to compression, and the other side to tension, and, since the compressive strength of pine is less than the tensile strength, the side next the load gives way first, and offers less resistance than it did, having the effect of decreasing the depth of the beam, or shifting the neutral axis towards the tension side of the beam. In all the beams tested it is plainly visible that the compression took place in more than half the depth of the beam, showing that the neutral axis was shifted; this would cause the modulus of rupture to be less than the tensile strength.

"When rupture of the fibers takes place, the beam is considerably deflected, and the fibers are not under a straight pull, but are pulled around a curve, and would therefore be weaker than if they were not bent."

The tests for compressive strength were made upon two-inch cubes. The average for thirteen tests was 5,498 pounds per square inch, for end compression, the heart being far more resistant than the sap, and seasoned timber more resistant than green timber.

"Testing for compression across the grain, it was found that the strength depended almost entirely upon the position of the grain. The specimens stood all the way from 1,200 to 12,000 pounds per square inch. When the grain was flat, the material would stand a very great stress without collapsing, although they were compressed to about half their original size. While, if the grain was placed vertically or diagonally, the pieces would stand very little stress before giving way."

Mr. Miles says that the specimens tested were more perfect than could be found in commercial timber, and recommends a reduction of the figures to 8,000 pounds for modulus of rupture and 4,000 for compressive strength, with six as a factor of safety.

Would it not have been better to give us the average figures for just such Georgia pine as enters into commerce, instead of tests of far better timber, from which a guess must be hazarded as to the figures that may be considered safe in actual practice? What is the use of a series of tests, if the final application is to be by guesswork?

The T-Square Club.

WE have received the thirteenth annual report of the T-Square Club of Philadelphia. The document is interesting in several respects. In the first place, it is printed in an artistic style, worthy of the art to which the membership of the club is devoted. Secondly, it plainly shows that the society may become an active and earnest factor of advance in the art of architecture in the United States. The club was founded in 1883. At first planned for the advancement of its individual members, it has now come to a stage of development wherein it can make its influence felt upon broader lines, and it has manifested a tendency to do this during the past year.

The lecture course of the architectural department of the University of Pennsylvania has been made available to the members of the club, who, at the close of the year ending October 23, 1895, numbered 118, but now number 133, notwithstanding losses during the year by death, resignation, and other causes.

Besides the lectures of the university course, special courses of lectures by able practising architects and professors of architecture in institutions of learning have been planned and carried out. A system of competitions has also been organized. A feature of the competition for this year has been the first annual prize re-designing competition. This is an innovation in competitions.

The society will hold an architectural exhibition in connection with the sixty-sixth annual exhibition of painting and sculpture at the Pennsylvania Academy of the Fine Arts, beginning on December 20, and continuing till February 2, 1897. The report says that this exhibition "will be the consummation of an idea which was first suggested to the club by Mr. Frank Miles Day and Mr. Edward Hurst Brown, in November, 1888. At that time a committee of T-Square Club men, consisting of Messrs. Eyre, Johnson, and King, was appointed to confer with the officers of the Academy, with the object of securing the use of a room during the annual exhibition for the display of architectural designs. Their overtures were approved of, and the desired space was allotted for the first architectural exhibition, which subsequently was prepared by a committee of architects composed of representatives from the local Chapter of the American Institute of Architects, and the executive committee of the T-Square Club.

"Those who have consulted the list of names making up the various architectural exhibition committees since then will find that, with few exceptions, they have been all those of T-Square Club men. This being fully realized, it was but natural that ultimately the exhibition should be held in the club's name.

"At this early date the exhibition committee deem it unwise to make any report, further than to state that all the preliminary arrangements have been made, and that they trust that its management may deserve the confidence of every one concerned, and it is also greatly to be hoped that both the Academy of the Fine Arts and the T-Square Club may reap mutual benefit of sufficient worth to make the present affiliation a permanent one.

"The T-Square Club has been conceded privileges by the Academy which should be greatly appreciated."

Altogether, the prospects of the club seem bright, and indicate a widening field of usefulness.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

CONSTRUCTION AND DESIGN.

*8658. The Cantilever as Applied to Building Construction. Ill. John Beverley Robinson (Pointing out the lines along which a new style of architecture may develop). Eng Mag—Nov. 4000 w.

8678. The Reibold Building, Dayton, O. (First part gives general plan, elevations and sections; wind bracing in walls; diagram of floor beams; details of columns and general description of design and construction). Eng Rec—Oct. 10. 1400 w.

8686. Stables. C. H. Blackall (The first of a series of articles on things to be considered in the construction of stables). Am Arch—Oct. 10. Serial. 1st part 2500 w.

8718. The Poulson Metal House (Illustrated description of a fireproof building which presents some unusual features obtained by the combination of iron and copper for exterior and interior construction and ornamentation). Sci Am—Oct. 17. 900 w.

8755. The Foundations of the New York Cathedral. From "Builders' Reporter." (Brief account of the difficulties encountered and overcome in laying the foundations for the new cathedral at Morningside Park, New York). Can Arch—Oct. 1900 w.

*8765. Fireproof Floors (Results of some experiments made at Berlin, under the auspices of the Royal Police Fire Brigade). Ill. Car & Build—Oct. 9. 2800 w.

8766. Safe Spans for Wooden Floor Joists, Ceiling Joists and Rafters in Buildings. F. E. Kidder (Tables showing the size of wooden joist to be used with the ordinary method of framing, with remarks). Arch & Build—Oct. 17. 800 w.

8792. Handling a Heavy Foundation Girder in a Tall Building (Describes the handling of a triple-webbed plate girder 52 ft. 6 in. in length, 61¼ inches in height, 2 ft. 6 in. in width and of a weight of about 37 tons, in the Queen Insurance Co.'s building, at Cedar and William streets, New York). Eng Rec—Oct. 17. 1300 w.

*8908. The Chemistry of Certain Metals and Their Compounds Used in Building, and the Changes Produced in Them by Air, Moisture and Noxious Gases, &c. John M. Thomson (Some of the changes which materials used in building undergo through the action of time or exposure to vitiating agents). Jour Soc of Arts—Oct. 16. 6000 w.

*8941. A Remarkable House (Illustrated description of a dwelling, devised by Dr. W. Van der Heyden, and built in Yokohama. It is constructed to shield the inmates from extremes of temperature, for economy in the use of fuel, protection against earthquakes and perfect sanitation). Engng—Oct. 16. 2500 w.

†9013. High Buildings. A. L. A. Himmelwright (An interesting discussion favoring high buildings and considering the arguments against them). N Am Rev—Nov. 2400 w.

*9022. American Building (An extended review of a recent work by F. E. Kidder, descriptive of American practice). Arch Lond—Oct. 23. 3400 w.

9101. London Public Conveniences (Illustrated description of an underground public convenience erected in London, and now generally adopted in English cities). Eng Rec—Nov. 7. 1300 w.

9104. Principles Governing the Design of Foundations for Tall Buildings. Randell Hunt (Read before the Technical Soc. of the Pacific Coast, April 3, 1896. The origin, characteristic construction with its advantages and disadvantages, &c.) Arch & Build—Nov. 7. Serial. 1st part. 4000 w.

9128. National Architecture; Certain Considerations Which Might Possibly Affect the Design and Construction of Our Buildings. William Martin Aiken (Read at the 30th An Con of A I A. Memoranda of principles, tending to the begetting of logical architecture). Am Arch—Nov. 7. 1700 w.

9129. Influence of Steel Construction and of Plate-Glass Upon the Development of Modern Style (J. W.Yost and Robert D. Andrews contributed papers on this subject to the 30th An Con of the A I A. Mr. Andrews treats the subject in regard to the effect on masonry design. Mr. Yost calls attention to the change in proportions of modern buildings due to steel construction and the general advantages and additional comfort to mankind from the use of these two materials). Am Arch—Nov. 7. 4500 w.

*9130. Glasgow Cathedral. T. L. Watson (The writer calls this the most important and most interesting building in Scotland. Part first gives a brief history of the building and a partial description of the design). Arch, Lond—Oct. 30. Serial. 1st part. 1700 w.

HEATING AND VENTILATION.

8754. Ventilating and Warming Stables (A dissertation upon the essentials of warmth and ventilation necessary to maintain the health of horses kept in stables; the amount of cubic space required per horse and the proper size of stalls). Can Arch—Oct. 2000 w.

8868. English Boiler Connections. Frederick Dye (Illustrated description and differences between English and American practice). Heat & Ven—Oct. 15. 2400 w.

8869. French Methods of Heating and Ventilating. G. Debesson (Principal French methods will be described. Part first deals with the possibilities of the introduction of American goods and methods). Heat & Ven—Oct. 15. Serial. 1st part. 1300 w.

8870. Warm Air Heating. S. Hampton Ripon (The subject will be discussed under five divisions. The first part is introductory and consists of general remarks). Heat & Ven—Oct. 15. 1000 w.

8871. Ventilation of School Buildings (Paper read before the Am Inst of Instruction, Bethlehem, N. H. Practical illustrated dissertation upon the inexpensive means of improving the ventilation of school buildings which have not been provided with adequate systems). Heat & Ven—Oct. 15. 2000 w.

8885. Indirect Heating in a New Haven Residence (Illustrated detailed description). Eng Rec—Oct. 24. 700 w.

9103. Heating of the Malden (Mass.) High School (Illustrated detailed description). Eng Rec—Nov. 7. 1000 w.

LANDSCAPE GARDENING.

8780. Park Lands and Their Boundaries (Editorial suggested by an article by Charles Eliot, in the New England Magazine, giving a sketch of the park system of Boston. The need of public parks in our large cities). Gar & For—Oct. 21. 1300 w.

PLUMBING AND GAS FITTING.

8674. Diameter and Inclines of Drains. A. B. Plummer (Abstract of paper read before the Sanitary Institute Congress at Newcastle-on-Tyne. Description of interesting experiments with flush tanks and drains, the object being to minimize the amount of water required for effective flushing). Arch & Build—Oct. 10. 1800 w.

*8784. The Plumbers' Craft and Education. Prof. Garnett (The remarks are directed to the better protection of the public health through the plumbers' art and to increased appreciation of the plumbers' work). Dom Engng—Oct. 1400 w.

*8785. Most Common Defects (As an aid to inspection, the most common defects are illustrated and described). Dom Engng—Oct. Serial. 1st part. 500 w.

*8786. The Trap on the House Drain (Against a current belief that traps on house drains should be abolished are opposed facts and experience). Dom Engng —Oct. 600 w.

*8787. Main Drain Traps and Their Disadvantages. F. W. Tower (An argument against the use of main drain traps). Dom. Engng—Oct. 1700 w.

8793. Plumbing in a Reconstructed New York Residence (General illustrated description). Eng Rec—Oct. 17. Serial. 1st part. 1600 w.

8878. New York Plumbing Regulations (Text of the recently revised code of the building department). Met Work—Oct. 24. 5500 w.

8879. Lead vs. Iron for Supply and Vent Pipes, from a Plumber's Point of View. William Eccles, in the Gas Light Journal (The question considered from an engineering point of view leads to the conclusion that galvanized iron will eventually almost wholly replace lead for supply pipes, while asphalt dipped black iron is better for discharge pipes in the plumbing of buildings). Arch & Build—Oct. 24. 1100 w.

MISCELLANY.

*8679. Some Sanitary Points in House Building. R. H. Ellis (Suggestions for choosing a site, character of the ground, precautions to prevent dampness in walls, and for smoky chimneys are dealt with in part first). Ill. Car & Build—Oct. 2. Serial. 1st part. 1800 w.

*8680. Builders' Ironmongery (Part first considers the branches into which the trade may be divided. The first of a series of articles aiming to help builders who feel the need of assistance). Ill. Car & Build—Oct. 2. Serial. 1st part. 1800 w.

*8682. North London House Property (Illustrations indicative of the class of modern houses built in this district, with some particulars and notes). Ill. Car & Build—Oct. 2. 2500 w.

†8709. The Temple at Deir-el-Bahari. Edouard Naville (Illustrated description of a beautiful Egyptian temple recently brought to light). Jour Roy Inst of Brit Arch'ts—Sept. 17. 2500 w.

†8710. International Competition for Theatre, Kieff (Account of a theatre to be built in a Russian town, in plans for which architects of all nations are invited to compete. Regulations for the competition are given, with plans). Jour Roy Inst of Brit Arch'ts—Sept. 17. 1500 w.

*8742. Government Tests of Building Stones (Report of J. W. Reilly concerning the scope of the tests made at the U. S. Arsenal at Watertown, Mass. Illustrated). Stone—Oct. 1800 w.

8743. Estimating from Bills of Quantities. G. Alexander Wright (Recommends the adoption of a national system of estimating from bills of quantities). Am Arch—Oct. 17. 3300 w.

8753. Loads and Strength of Roofs. From the Contract Journal (Calling attention to the dead and live loads necessary to be considered in making estimates of the weights of roofs). Can Arch—Oct. 2000 w.

*8900. An Architectural Symposium (Report of a talk on the aims and position of modern architecture in one of the lecture rooms of the Architectural Association, London). Builder—Oct. 17. 2200 w.

*8902. The Evolution of Christian Architecture (Abstract of address by Prof T. Roger Smith at University College. Brief review of important steps in its progress). Arch, Lond—Oct. 16. 900 w.

*8903. The Church and Art (Abstract of paper read by Mr. Holman Hunt at the conversazione given in the Music Hall during the Church Congress. Refers to early prejudice against painting and sculpture in the church, and traces the inflences which have changed public opinion). Arch, Lond—Oct. 16. 1200 w.

†8909. The Letting of Contracts. Geo. Beaumont (Address before the Building Trades Club, of Chicago. Discusses the various difficulties and suggests remedy). In Arch—Oct. 2800 w.

8912. The Application of Sheet Zinc for Roofing and Other Purposes. W. H. Seamon (Much interesting information relating to the zinc industry is contained in the article. Part first deals largely with the use of zinc in roofing). Eng & Min Jour—Oct. 24. 1700 w.

*9024. The Analysis of Mortar. W. J. Dibdin and R. Grimwood (Read at the Summer meeting of the Society of Public Analysts and published in the Analyst. Provisions made iu the by-laws of the London County Council with methods of analysis and experiments). Arch, Lond—Oct. 23. 2500 w.

9025. The Training of Workers in the Applied Arts. Robert Anning Bell (Read before the Liverpool Society, Nov. 11, 1895. Describes means of attaining results that the writer considers desirable). Arch & Build—Oct. 31. 3000 w.

†9041. Work of the Committee on Fire-Proofing Tests. S. Albert Reed (The co-operative committee of three, representing the Fire Insurance Underwriters, the Architectural League and the American Society of Mechanical Engineers. Interesting information with tests thus far made). Jour Fr Inst—Nov. 4000 w.

9096. Tests of the Roebling Fire-Proof Floor (A protest was sent to the N. Y. Building Dept. claiming that the two hours' test was not sufficient, so a second test for a period of five hours was made and is here described). Eng News—Nov. 5. 800 w.

*9132. Metal-Work Exhibitions, Glasgow (Illustrated description of exhibits). Builder—Oct. 37. 1300 w.

*9145. The Early Renaissance in France. G. A. T. Middleton (Illustrated description of examples of this type of architecture with comments). Arch Rec—Oct.-Dec. 2000 w.

*9146. Sculpture as Applied to the External Decoration of Paris Houses. Fernand Mazade (Illustrated description of some of the applications, with record of the progress in the last twenty years). Arch Rec—Oct.-Dec. 4200 w.

*9147. Perspective Illusions in Medieval Italian Churches. William H. Goodyear (A study with illustrations of the churches of Italy, giving especial attention to the churches of Pisa). Arch Rec—Oct.-Dec. 7000 w.

*9148. The Works of R. H. Robertson. Montgomery Schuyler (Biographical sketch with illustrated description of his most important works and favorable criticisms). Arch Rec—Oct.-Dec. 9000 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Bridge Work.

THE engineering papers of late have been profuse in their illustrations and descriptions of new bridge structures. A glance at our index of civil-engineering literature for the current month and for several months previous will show the importance and magnitude of this branch of civil engineering as compared with other branches. Two very interesting specimens of bridge work have been recently described and illustrated,—one over the Harlem river at Third avenue, New York city, and another designed to bridge over Newtown creek, affording a passage from Vernon to Manhattan avenues on the Brooklyn side of the East river. The former, illustrated and described in *Engineering News* (Nov. 5), is one of the largest and heaviest draw-bridges ever constructed. The latter, described and illustrated in *The Engineering Record* (Oct. 31), is a bascule bridge, operated by hydraulic rams and counter weights. It is said that the design of the latter, prepared by Thomas E. Brown, Jr., of New York city, has been definitely adopted by the Queens county board of supervisors and the Brooklyn board of aldermen. The design has been accepted against considerable competition with other designs, which included the Waddell system of lift bridge and the Breithaupt interlocking arch segments with suspended floor. A description of the Waddell's lift bridge over the Chicago river at South Halsted street, Chicago, was printed in *The Engineering Record* and in other engineering papers in the spring of 1893. The Breithaupt system of interlocking arch segments with suspended floor was illustrated and described in the newspaper named, in its issue of August 8, 1896.

Mr. Brown's design differs materially from the bridges of Waddell and of Breithaupt, its special features being shown in diagrams and described in *The Engineering Record* (Oct. 31). Those who wish to study the details must consult that article, which says that "the essential elements" of the design "are a double bascule, the free ends of which are supported when under traffic by movable, vertical columns seating on the river-bottom; heavy constant counterweights with points of attachment automatically shifted to correspond with successive positions of the centers of gravity of the revolving bascules, and of the operation of each leaf of the bascule by two pairs of horizontal hydraulic cylinders, working directly through simple pairs of links without ropes, pulleys, gears, racks, or other intervening mechanism."

It is added that "the floor trusses are proportioned for a live load of eighty pounds per square foot of floor and for two fifteen-ton trolley cars, and a wind-pressure of thirty pounds per square foot. The floor system is proportioned for a live load of one hundred pounds per square foot and for two fifteen-ton trolley cars. The counterweight cables are proportioned for a strain of 100,000 pounds, and the lower batter posts of the towers for 407,000 pounds each." The design is ingenious and well worked out, and furnishes a good study in the construction of this class of bridges.

The Harlem bridge is remarkable not only for its size, but because in it an attempt has been made to secure a more pleasing appearance by a modification of the standard American form of swing-span truss. The first impression made upon us by a look at this modification of form suggested at once the legend on the now familiar placard of a certain hook-and-eye manufacturer,—"See that hump?" The hump can not help being seen, and, we fear, will fail to compel admiration as an esthetic improvement upon swing draw-bridges. *Engineering News* says: "There may be some things in the field of engineering construction more awkwardly ugly than the ordinary swing-span truss as usually constructed, but we do not now recall what they are. The attempt to remedy this by the introduction of curved outlines, which has been made in the present instance, is a most interesting experiment, and opinions will differ as to its success. We are inclined to believe that a more radical departure must be made from conventional forms, if the swing span is to be made a thing of beauty."

Another notable feature in this bridge is the employment of multiple-intersection lattice trusses for a bridge of this size, which, our contemporary says, "with the curved top chord," "have made necessary great care and accuracy in the shop and field work."

The structure is now complete, and, as soon as the approaches are finished, will be opened for traffic. This traffic not only is large at present, but is rapidly increasing. The swing-span must, therefore, be rapidly worked. This span is three hundred feet long and eighty-seven feet six inches wide, and it weighs 2,500 tons. The design is to swing this immense mass open or shut in two minutes. The span is supported on a turn-table sixty feet in diameter, running on eighty twenty-four-inch wheels. The movement is so easy that the span can be worked by hand power, but, in order to work it in the time specified, two fifty-h. p. steam engines are employed, either of which is sufficient to work the bridge. In case anything should necessitate the stoppage of the engine in use, the one in reserve may be at once put into service. Two boilers, each of sixty h. p., are to be installed, only one of which will be required, the other being held in reserve.

There are other interesting details of this bridge, but we pass them, our purpose having been served in calling attention to the important place now held by bridge-building as a branch of civil engineering, to the ingenuity displayed in meeting special requirements as they arise for different sets of conditions, and to the illustration of these points afforded by the articles we have thus briefly reviewed.

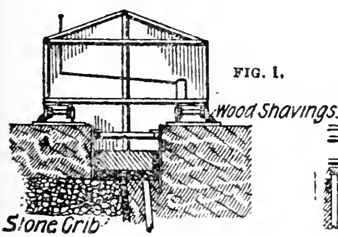


FIG. 1.

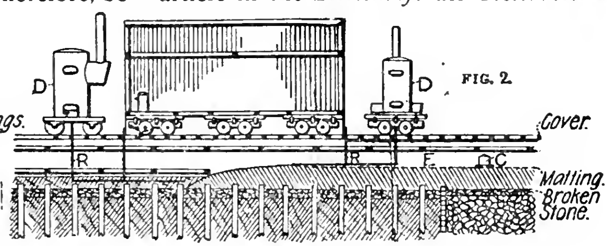


FIG. 2.

Concrete Work in Cold Weather.

THE construction of concrete work, or the use of cement and mortar in winter weather, even of the severest sort, has become so common under the intensified building methods of recent years that the practice is no longer regarded with distrust, and indeed hardly excites more than a passing interest; but the details of some work recently executed at Helsingfors, Finland, are unique, and warrant the attention given them in the *Engineering Record*, which presents an abstract from an article in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines*.

The work was performed during the winter of 1895, and consisted in constructing foundations for a warehouse and two railroad-bridge piers. The necessity of completing the work in time for the rather brief summer season of maritime navigation induced the prosecution of operations during the winter, although the temperature ranged between 14° above and 40° below zero, F.

The foundation of the warehouse, in which the protection from weather was most essential, rested partly on the stone crib-work of an old quay and partly on piling, concrete being used to distribute the pressure. It had a depth of 31 inches and a breadth of 46 inches. "As this work was begun in early February," says the *Engineering Record*, "with the thermometer 4° below zero, F., especial care was needed in the preparation, placing, and protection of the concrete until set. For this purpose a movable house, heated by two coke stoves, was mounted on wheels over the trench. This house was about 26 feet long and 20 feet wide, and was mounted on six four-wheel trucks. (See Figs. 1 and 2.) In this house, during the mixing of the concrete, the temperature was kept at about 54° F. The stone and sand were brought into the house in as large quantities as possible, and warmed before using. When mixed, the concrete was placed in the trench through the three trap-doors in the floor of the houses. These are indicated in Fig. 2, which shows the elevation of the house. To keep the outer air from the trench, the walls of the house were continued down to the ground by movable weather shields, whose edges were packed with coarse matting and wood shavings. As the ground water standing in the trench before the house moved up was always frozen hard and the ice between the piles was very difficult to chop out, steam boilers, mounted on wheels, as shown in the figures, were utilized to thaw out the ice and soften the ground by means of the steam pipe, R. When the ground under the house and a little in advance had been thawed out, a twelve-inch layer of broken stone was packed in. The concrete was mixed by hand, with the water warmed to between 158° and 176° F. The proportions of the bulk of this were 1:5:6, and of the upper layer 1:3:5.

"To protect the concrete until set against the entrance of frost from the sides of the trench, sheet piling with a filling of broken stone was used, as shown in Fig. 1.

"As soon as placed, the bed thus prepared was covered with a double layer of straw matting, and the whole trench-space given a covering of plank, matting, and trodden snow. The house was then moved on, and the space left, as shown at E, in Fig. 2, warmed by the kettle, C, filled with burning coke. This kept the temperature of the air at about 54° F., and insured the setting of the concrete in warm water. The value of the precaution was shown at one corner of the building, where the concrete was badly damaged by an exposure to the air one night at a temperature of 20° F. The rest of the concrete hardened inside of two days, and eight days after the construction of the upper masonry was in progress."

The Influence of Sand-Grains in Cement Mortars.

A SUGGESTIVE field for study and investigation is opened by a paper on the effect of the granulometric composition of sand upon cement mortars made from it, prepared by M. R. Feret, chief of the Laboratoire des Ponts et Chaussées at Boulogne, and reproduced by the *Engineering Record* from a translation by Capt. O. M. Carter and Assistant Engineer E. A. Geiselr, U. S. A.

The paper, which, unfortunately, is not very clear in translation, is chiefly a suggestion of the scheme of tests to be followed out in determining the suitability of any given sand, or of deciding between two or more alternative sources of supply; for, according to M. Feret, the problem has so many variables that "sufficient information," in any special case, "can be obtained only by the study *a posteriori* of a series of test-mortars obtained by combining in different proportions the sand and cement considered."

	250-Kilogram Mortars.	500 Kilogram Mortars.
Volume of mortar furnished by 1 cubic meter of sand (yield).	From 0.940 to 1.030 m³.	From 0.970 to 1.180 m³.
Weight of cement entering into 1 cubic meter of mortar......	From 243 to 266 kg.	From 424 to 516 kg.
Absolute volume of solid materials entering into the unit of volume of the mortar $(c+s)$...	From 0.570 to 0.737.	From 0.565 to 0.728
Volume of voids remaining in the unit of volume after drying (porosity)...	From 0.145 to 0.330.	From 0 093 to 0.210.
Decomposition by salt water after one year's continuous immersion	All degrees, including total absence of disintegration.	No disintegration.
Resistance to compression per square centimeter after one year's immersion in fresh water	From 35 to 130 kg.	From 100 to 200 kg.

To enforce this conclusion, M. Feret presents a table showing the wide range of results, under various tests, obtained from various samples of mortar which differed one from another only in the sizing of the sand grains. The table is thus introduced:

"It has been shown that, in whatever manner sand is measured,—by weight or by volume,—the ratio of the resistances of mortars obtained by combining the same weight of cements with sands mineralogically identical may vary from one to three, according to the proportion of the different sizes of grains contained in those sands. The other properties of mortars—permeability, decomposition by salt water, etc.—depend almost entirely on the granulometric composition of the sand.

"The most important test to which sand should be submitted will then consist in measuring the proportion of grains of each size which it contains.

"It is proposed to call pebbles all grains remaining on a plate perforated with circular holes 5 millimeters in diameter, and to divide the pure sand into three sizes defined according to the diameters in millimeters of the circular holes in perforated plates serving to separate them.

"Large grains (G): pass 5 millimeters; remain on 2 millimeters.

"Medium grains (M): pass 2 millimeters; remain on 0.5 millimeter.

"Fine grains (F): pass 0.5 millimeters.

"The proportions of those three classes of grains expressed in hundredths of the weight of pure sand will make known the granulometric composition of the sand. The proportion of pebbles expressed as a function of the weight of pure sand will also be indicated.

"Numerous experiments made on mortars of mixtures of 250 and 500 kilograms of the same cement to the cubic meter of sands of the same nature (ground quartz), differing only in their granulometric composition and measured always in a dry state in the same manner, have shown, as can be seen by the examination of the table below, that mortars of the same proportions can have very different properties.

"Hence it is evident that an indication of the proportion or composition of any mortar suitable for employment in any given work has no signification when the sand is not defined, and that, according to the sand which is used, the proportion of cement to be combined with it must vary. It is important that there should be determined for each sand the proportion-mixture to which any given quality of mortar corresponds."

The Regularization of the Danube.

ONE of the most important engineering events that has recently occurred is the formal opening of the Iron Gates of the Danube, which took place September 27, the occasion supplying the text for an able editorial review of the present status of the work in *Engineering* (Oct. 2). It is, perhaps, a too frequent incongruity in great enterprises that their formal opening is not always an indication of the completion of the work. Particularly has this been the case in the history of great canals and artificial waterways. So, in this work of removing the obstructions to navigation from the bed of the Danube, and the opening of the river through the so-called Iron Gates, the completion is still deferred, though the channel has been improved sufficiently to permit the passage of vessels through sixty-five miles of the course hitherto practically unnavigable. An open channel of six feet and seven inches of water throughout the entire year has thus been supplied between the upper and lower channels.

In *Engineering* (June 9, 1893) the history of ancient and modern works directed to improvement of navigation in the Danube, and of the numerous schemes for proposed improvement, was presented.

The work has been a large and expensive undertaking, involving the removal of 258,500 cubic meters of rock from under water, and 362,500 cubic meters of other rock. About 783,000 cubic meters of rock have been laid into dams and walls. The rubble shot was about 258,000 cubic meters.

The difficulties encountered have been greater than was anticipated. The blasting has been on an unprecedented scale for this class of work. A maximum charge of 26,000 pounds of dynamite was used on one occasion, but other very large charges were used at times, and with great effect. Blasting with large charges of powerful explosives has been made a study by able engineers, and will doubtless be more practised hereafter.

On the cutting of channels under water *Engineering* says that " many experiments had to be made before the cutting proceeded satisfactorily. Most of the appliances suggested were quite impracticable." Dynamite cartridges dropped into the bed of the river upon the rock gave satisfaction only in disposing of loose stones; massive rock was little affected by them. It soon became apparent that drilling and subsequent blasting can be recommended only for depths of more than twenty inches, and that, for very uneven bottoms and excavations of lesser thickness, the rock-crushers, first applied in the Suez canal, answer best. Of the drilling-machines it is pleasant to note that the Ingersoll rock-drill (American) is named as among the best working appliances.

Many valuable data upon the action of explosives have been gained ; and, generally, it may be said that the execution of every large work like this leaves the engineering profession better equipped for carrying out any similar work in the future.

The Water-Revenue of a Nation.

Mr. C. E. De Rance, of her majesty's geological survey, makes some very interesting and important suggestions in a paper on " Hydro-Geology and Hygiene," originally read before the British Association of Water-Works Engineers and recently republished in *The Canadian Engineer*.

Mr. De Rance's illustration and application are, naturally, chiefly local; but the main line of his argument is even more forcible as applied to American conditions, for we have been singularly inattentive to the important branch of engineering study which constitutes his topic.

Sketching briefly the history of the line of observation upon which the further study of the subject rests, Mr. De Rance says :

" The term hydro-geology, to express the study of the passage of water when, as rainfall, dew, or snow, it reaches the surface of the ground, or percolates beneath it, appears to the writer to deserve more general acceptance than has been accorded to it. It appears to have first been used by a French Jesuit priest about half a century ago, and was adopted by Mr. Lucas in his studies on the chalk-water supply of the south of England twenty years since.

" A Lancashire squire, one of the Towneleys of Townley, near Burnley, appears to have been the first to systematically observe the amount of rain falling more than two hundred years ago; a century later, in 1766, a rain gage was placed on the top of the square tower of Westminster Abbey by Dr. Heberden, F.R.S. Early in 1861 G. J. Symons, F.R.S., began his magnificent organization; his modest pamphlet of four pages of that year, with 168 observers, has now blossomed into a volume of 254 pages, with a staff of 3,043 observers. Looking to the bearing of the inquiry on manufacturing, engineering, agricultural pursuits, and the health of the inhabitants, it is remarkable that such an investigation should be left by the nation to the self-abnegation and industry of this remarkable voluntary effort. Mr. Symons's annual volume is a record of the nation's ' Water Revenue,' on which depends the amount available to be consumed by men and animals, to be absorbed by agricultural crops and forests, or utilized in manufacturing processes, purposes of inland navigation, the production of steam and electric energy, and the preservation of fisheries. From the amount recorded, large amounts have to be written off from several causes, which probably vary from year to year: (1) evaporation, which is governed by the comparative dryness or wetness of the air at the moment of the rainfall; (2) the amount percolating, which varies also according to the comparative dryness or wetness of the soil, in dry periods vegetation taking up a very large proportion, and, indeed, after long periods of drought the whole of the volume percolating is so arrested, and none sinks to replenish the underground storage; and (3) lastly, there is loss from transit of percolation water into areas where the supply cannot be obtained by pumping. This is the case when the sectional area of a porous rock, where it dips and disappears beneath overlying impermeable material, is sufficient to discharge the water into outside areas,—*i.e.*, tidal rivers on the sea. Of the rainfall that is absorbed by the area of outcrop of the porous rock, nothing goes into the streams until rainfall additional to the amount that runs to waste causes the saturation level in the porous rocks to rise above the level of the V-shaped valleys which intersect it, and, in the case of dry valleys, a 'bourne,' or temporary stream appears."

The history of rainfall observation has a passing interest only; our own weather bureau has an admirably developed system for this part of the work, and exhaustive table of averages, maxima and minima, by sections and by seasons, from which almost any required data may be immediately obtained.

The point to which attention should be drawn is the study of the possibilities of utilizing or controlling the rain after it has fallen,—the treatment of the entire subject in the light of the conception strongly conveyed in a single phrase: "The Water Revenue of a Nation."

From this conception Mr. De Rance develops a suggestive system of control and utilization, based largely on English political organization and adaptable to American conditions only after radical remodification, but embracing as its four principal features (1) topographical and sub-surface examinations to determine the location and extent of potential water-supplies; (2) extensive and systematic observation of surface-flow in streams and rivers, with the collateral establishment of a flood-warning service; (3) stream-control by competent boards in the interest of the entire public; and (4) the establishment of storage reservoirs for the prevention of floods and the conservation of now-wasted flood-waters.

The second service is now being rendered by our water bureau to some extent at least; the fourth falls directly in line with the suggestion made in this magazine not long since in the article entitled "The Causes of Floods in Western Rivers."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

BRIDGES.

8717. The Essex-Merrimac Bridge. Horace C. Hovey (Describes what is known as the Essex-Merrimac bridge, crossing at Deer Island from Newburyport to Salisbury. It has existed in two different forms, each having a bearing on the general interests of bridge building). Sci Am.—Oct. 17. 1600 w.

8789. The Design of Drawbridge Details (Abstract from book by Charles H. Wright. The article is a clear presentation of the subject of plate-girder draw-spans and their machinery, and is well illustrated). Eng Rec—Oct. 17. Serial. 1st part. 2500 w.

*8854. The Snodland Bridge Over the River Medway (Illustrations and brief description of a unique design on a new line of bridge construction with arched steel tubes). Eng, Lond—Oct. 9. 400 w.

8884. Building a Small Stone Highway Bridge (Bridge designed by J. F. Fisher, of Chicago. Data of design and construction, with elevation). Eng Rec—Oct. 24. 1300 w.

9019. The Newtown Creek Hydraulic Bascule Bridge (Description of accepted design for a bascule bridge operated by hydraulic rams and counterweights for the crossing from Vernon to Manhattan avenues. Illustrated by diagrams). Eng Rec—Oct. 31. 450 w.

*9023. London Bridge. A. J. Glasspool (Historical review, mostly relating to the old London bridge). Arch, Lond—Oct. 23. 2200 w.

9093. The Third Avenue Drawbridge Over the Harlem River, New York City (Illustrated description of one of the largest and heaviest drawbridges ever built). Eng News—Nov. 5. 1000 w.

9094. The Newtown Creek Bridge Competition (Facts in connection with this much discussed piece of engineering work, with illustrated description of designs submitted). Eng News—Nov. 5. 5500 w.

9095. The Design of Movable Bridges (Editorial discussion of interesting questions in connection with this subject). Eng News—Nov. 5. 2500 w.

9100. The Erection of the Belle Isle Bridge (Illustrated description of bridge over the Detroit River, constructed to meet unusual conditions of soil and water). Eng Rec—Nov. 7. 700 w.

*9115. Fixed Girder Bridge Over Great Ducie Street, Manchester. J. Gilchrist (Description of a metal bridge under conditions made difficult by want of room for construction). Engng—Oct. 30. 3300 w.

CANALS, RIVERS AND HARBORS.

*8667. Harbor Improvements in Western Australia (The first part relates to the harbor of Fremantle mainly. The need of a harbor at this point is shown and the two schemes proposed for the improvement of the harbor are presented). Engng —Oct. 2. Serial. 1st part. 2000 w.

*8669. The Regularization of the Danube (Some historical particulars and features of the task, with account of the character of the work and difficulties encountered). Engng—Oct. 2. 4000 w.

*8672. The Iron Gates of the Danube (Illustrated description of this difficult work, now nearing completion). Eng, Lond—Oct. 2. 5300 w.

*8683. The Opening of the Iron Gates (Editorial on the removal of the obstructions to navigation in the Danube). Trans —Oct. 2. 1800 w.

*8684. Harbor Development in South Africa (General plan of East London Harbor, with account of improvements). Trans—Oct. 2. 2200 w.

8880. Improving New York's Canals (Report as to the nature of the work to be immediately undertaken. The worst portions of the Erie, Oswego and Champlain canals to be first improved). Sea—Oct. 22. 3000 w.

8938. Suspended Arch-Centers at the Port of Bordeaux (A novel feature of construction is illustrated and described. The work was done in building the new quays at the port of Bordeaux, France, and made necessary by the conditions and the character of the soil). Eng News—Oct. 22. 800 w.

8973. The Breakwater Extension at Buffalo, N. Y. (Illustrations taken from the Government specifications, showing the general construction of both the rubble and timber work, are given). Eng News —Oct. 29. 800 w.

9072. The Lake Biwa-Kioto Canal, Japan. Sakuro Tanabe (Illustrated description of a canal constructed with the objects of opening a line of boat navigation between the lake and Yodo River through Kioto, the production of water power and the distribution of power and light in the city by electricity, and the irrigation of rice fields in the vicinity). Sci Am—Nov. 7. 1400 w.

9073. Opening of the Danube to Navigation (From Illustrirte Zeitung. Illustrated historical account of this great engineering work). Sci Am Sup—Nov. 7. 3000 w.

†9092. The Discharge of the St. Lawrence River. C. H. McLeod (Investigations made by the students of McGill University under the direction of the writer and assistants. Illustrated by diagrams). Trans Can Soc of Civ Engs—June. 1800 w.

HYDRAULICS.

8791. The Gileppe Dam (Illustrated description of one of the great dams of the world). Eng Rec—Oct. 17. 600 w.

*8993. Uniform Flow in Open Channels. E. S. Bellasis (The paper proposes to supply information regarding the practical aspects of the subject, especially the laws which govern the action of a stream on its channel. Part first consists of preliminary remarks, definitions, &c.). Engng —Oct. 23. 2200 w.

†9091. The Storage of Water in Earthen Reservoirs. Samuel Fortier (Opinions expressed, suggestions offered and consideration of practical features relating to reservoir dams and the storage of water). Trans Can Soc of Civ Engs—Oct. 7400 w.

MISCELLANY.

*8758. Methods and Results of Stadia Surveying. F. B. Maltby (Notes on the practical use of the stadia as gained principally from the writer's own practice. Methods employed, with examples of results attained). Jour Assn of Eng Soc. —Sept. 10000 w.

8790. Construction of Concrete Foundations in Cold Weather. M. Strukel (Abstract from an article in the Zeitschrift des Oesterreichischen Ingenieur und Architakten-Vereines. Description of successful work accomplished with the thermometer between 14° above and 4° to 40° below zero). Eng Rec—Oct. 17. 1000 w.

*8857. Ore Shipping Piers on the Cantabrian Coast (Brief illustrated description of piers designed to meet special needs). Eng, Lond—Oct. 9. 700 w.

8937. Engineers and Speculative Enterprises (The "Code of Ethics" adopted by the Canadian Society of Civil Engineers—supplies the text for a strong editorial discourse deprecating the connection of engineers of good standing with enterprises of questionable character). Eng News—Oct. 22. 1400 w.

*9131. The Management and Position of Rural Roads (The system under which rural highways are managed in England). Builder—Oct. 31. 1700 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

The British Post-Office Tests of Incandescent Electric Lamps.

In its practical bearing upon the future of electric lighting, Mr. W. H. Preece's paper read before the Mechanical Science Section of the British Association, describing official tests instituted and carried out by the British post-office, is of the very first importance. The extent to which the public has been imposed upon by the representations of manufacturers in the sale of lamps since the termination of the Edison-Swan patents is well shown by the results of these tests. *The Electrician* (Sept. 25), in its report of this paper, presents a series of eighteen diagrams on a large inset sheet, which afford the following data:

(*a*) Curves of candle power and life of the lamps of twenty-three prominent manufacturers.

(*b*) Efficiency curves.

(*c*) Curves of candle power of lamps of eight other manufacturers.

(*d*) Curves connecting time with candle-power (percentage) and watts per candle respectively, for lamps of initial watts per candle-power of three to four, of more than four, and of two to three; also for fourteen lamps of more than four watts per candle, of nineteen lamps of three to four watts per candle, and three lamps of from two to three watts per candle.

(*e*) Curves showing percentage of lamps replaced.

(*f*) Curves connecting cost per candle-hour and time for fourteen lamps—initial watts more than four, nineteen lamps—initial watts between three and four, and three lamps—initial watts between two and three.

This sufficiently displays the extent and nature of the investigation, and it is difficult to overestimate the value of the data furnished. Of the methods employed in these tests *The Electrician* regards as the most praiseworthy "the practical method by which Mr. Preece 'ages' a lamp. . . By stressing it for something like a couple of minutes to nearly twice its working pressure, he obtains some idea as to its quality and probable life.

"The post-office test for india-rubber is based upon an analogous principle, which has been recognized as a good one by the board of trade in their insistance upon stressing tests of an hour duration for central-station plant. Incandescent lamps may now be tested for: (*a*) efficiency; (*b*) life; (*c*) breaking-up pressure; (*d*) results after stressing to three-fourths of their mean breaking pressure. The latter two tests are comparatively novel, and seem for the first time to have been entered upon systematically.

"The life history of lamps—including, as it does, the results of a gradual deterioration in the light-giving filament—seems to establish a falling off of candle-power coincident with a rise in the watts per c.p. Some lamps, as has been shown by Prof. Ayrton, and corroborated by Mr. Preece, show an increase of candle-power at first, afterwards diminishing to the original value, and then falling below it. The average consumer requires a lamp that has a fairly flat c. p. curve until the filament gives way; otherwise, as time goes on, there are sure to be complaints about the supply. Of equal importance is the efficiency; this must be fair, or the cost of lighting is found to be a great objection; but high efficiency has, so far, not proved altogether a success. Mr. Preece says 'the so-called high-efficiency or economical lamps evidently suffered more than those of about 3¾ watts per candle' in the life tests. This corresponds with actual experience on a large scale, and we have frequently pointed out that the demand indicators on consumers' premises usually read as if a 16-c.p. 100-volt lamp took 0.6 to 0.66 ampere, while the 8-c.p. lamp gives nearly 10 c.p. on the average, and certainly is not overrated if taken as a 35-watt lamp. Mr. Preece's figures for current show a rather better result in this respect.

"The breaking-down test and stressing test will probably be largely used by lamp-buyers in time to come. Lamps of 100 volts put on a 200-volt circuit frequently go at once, so it is evident that the test requires care in its carrying out. Lamps of 16 c.p. run, say, in an engine room where the pressure is raised 10 per cent. above the normal at the time of heavy load, each evening, do not last very long, 100 to 150 hours being the average. On the other hand, the curious fact has been noticed that high candle-power lamps (such as 200 c.p. and 300 c.p.) last 700 or 800 hours under the same conditions, but with excessive blackening. What lamp-makers think is manifested by the statement in the recently-issued catalogue of the Ediswan Company that 'lamps marked 100 volts are not intended to be run systematically at 102 volts.' After all, the pressure variations on a London central-station circuit frequently amount to 4 or 5 volts every evening at points close to the generating stations or feeding centers, and lamps are bought to be used with the public supply as it is, not as it should be. The life of 3½ to 4 watts per c.p. lamps may be taken as twice that of high-efficiency lamps, and Mr. Preece's figures substantiate that, while 'a short life and a merry one' is a good adage, if not carried to extremes, we are yet without a satisfactory high-efficiency lamp."

There is an amusing phase of this important investigation which, if we wanted to be funny, we should call "The Drop Act." The performances of some lamps seem to justify this appellation. Rated at sixteen candle power, they started at from twelve to fourteen, and with celerity fell to lower efficiency. This drop in efficiency seems a general characteristic of incandescent lamps, but it varies largely in lamps of different make.

The *Journal of Gas Lighting* classifies the lamps with reference to this point as follows: "(1) Those that start at about their nominal candle power at a high efficiency, but very quickly show a decided falling off in candle power and efficiency, and become practically useless in 400 or 500 hours; (2) those that start off at about their nominal candle power, give a useful light for about 1,000 hours, and then burn out; (3) those that start off like those in the second class, but do not break; and (4) those that start off with a candle power below their nominal value, and keep it up fairly steadily, for 2,000 hours or more. The two middle classes are apparently the most promising lamps for practical service; but the difficulty is to identify them quickly and reliably."

The consumers of incandescent lamps may congratulate themselves upon the investigation and the published results, which will no doubt have a beneficial effect upon the framing of specifications henceforward. The fact that the names of the different makers of the lamps tested are given with the results of the tests adds much to the value of the report to the general public.

The Potential of Steam.

THE substantive term "potential" has been used in a variety of ways. It fundamentally means a possibility. One of its most common uses is found in electricity, wherein it indicates the capacity for work in an electric current at any point in a circuit; but this is by no means an exclusive use of the word, as any one may see by consulting a good modern dictionary.

As good writers on electricity have, moreover, already admitted that "'capacity for doing work' and 'potential' are convertible terms,"* without any restriction as to the mode of energy which manifests the potential, we scarcely understand how it can be said that the term has been "monopolized by electricians." Such, however, is the allegation of a Royal Hibernian Academician, put forth in a paper read before the Institution of Civil Engineers, Ireland, the first part of which is published in *The Electrical Review* (London, Oct. 16). We agree with the author of this paper, Mr. Howard Pentland, that

*Slingo and Brooker, "Electrical Engineering," page 6.

the term "potential" may be appropriately and usefully employed more frequently in discussions of work derived, or possibly to be derived, from any source of energy, including steam; but we hardly think he is right in his charge of monopoly. At the same time we heartily approve his proposition to employ a uniform nomenclature for steam and electricity, and the lines he marks out on which the approach to uniformity may be practically made. He says: "If we discuss with a central-station engineer the theory of the most advanced form of steam dynamo, say, a large Sayer's patent continuous current shunt wound machine, with an efficiency of about 95 per cent., driven directly by a Willans patent central valve compound engine, with an efficiency of about 90 per cent., giving a combined efficiency of about 85 per cent., it will be observed that he uses two languages, the foot-pound-second language on one side, and the centimeter-gram-second language on the other side, of the fly-wheel. Bring him to one end of the common bed plate, and he talks of horse-power, foot-pounds, pounds-per-square-inch, and British thermal units. Bring him to the other end, and he talks of watts, joules, volts, and calories."

"A constant stream of energy flows through the steam dynamo from the boiler. The energy of the coal is converted into the energy of the steam, the energy of the steam into the energy of the shaft, and the energy of the shaft into the energy of the electric current. Not only, however, does the unit of energy-measurement change at the last conversion, but the very principle of measurement on which the unit is based. However desirable, therefore, may be the substitution of the centimeter and the gram for the foot and the pound,—a course I have no intention of now advocating, although the kilowatt is slowly but surely driving the horse-power out of the modern specification,—it leaves the main evil untouched. Energy, or the capability for work, is measured, in respect of quantity, on the same principle on both sides of the fly-wheel, but, in respect of degree, on three different principles! It stands to reason that, whether it be desirable to adopt the centimeter-gram-second system or not, it is, at all events, desirable to have a common principle of measurement throughout, not alone for the energy which goes in through the furnace door or the steam port and comes out through the brushes, but for its *degree or potential*."

Now this is sound, common-sense talk. As well might we have one set of units for measuring length, girth, and weight of live oxen and another for dressed beef as separate sets for the same thing in steam and electric engineering.

Mr. Pentland says:

"The potential of both coal and saturated steam is now estimated in British thermal units per pound, the potential of the expanding steam in pounds-per-square-inch, and the potential of the electricity in volts—in fact, by heat pressure and *work*. Why not by *work* throughout? . . . The sooner steam users awake to the fact that the idea of potential is a general conception which is no more concerned with electricity than with steam, water, coal, the luminiferous ether, dynamite, beef, or any other substance whose energy, temporary or constant, ministers to our needs, the clearer will be their mental vision, and the less their mental labor in the domain of energy, work, and power. For many years men have reasoned about the pressures of water, steam, and air, the level of lakes, the run of clock weights, the loudness of notes and noises, the temperature of gases, the candle-power of lamps, and the velocities of projectiles, and they have recognized that, although these things require distinct measurement by foot rules, gages, thermometers, photometers, phonometers, ballistic pendulums, and the like, they are manifestations of the one thing whose common measure is work,—namely, energy, or the capability for work. But, while they have recognized this, they have failed to see that, although steam and electricity are incommensurable in respect of quantity, the degree of energy or potential which they possess may be measured, if not by the same unit, by a unit based on the same principle, which in each case shall bear the same relation to the unit of quantity as specific gravity to weight, or specific heat to total heat."

The author then defines "potential" as "specific energy," or specific capability for work, or the capability of the unit quantity for work. He then argues that the possibility exists for expressing the qualities of the energy of steam in the same terms as are used for expressing the qualities of an electric current.

"It is an extraordinary fact that, although work per unit is the true measure of potential, there are no less than seven measures and *quasi* measures of potential in use,—namely, (1) *height or level* in feet, as in the case of water or clock-weights; (2) *pressure* in pounds-per-square-inch, as in the case of water, air, or steam; (3) *quantity of heat* in British thermal units, or in calories, as in the case of fuels or saturated steam; (4) *temperature*, as sometimes in the case of steam in degrees F. or C.; (5) *mechanical work* in foot-pounds or in joules, as in the expansive use of steam; (6) *electrical potential* in volts, in the case of electrical currents and condenser charges; and (7) *lucic intensity* in luxes, in the case of light. No one, however, has as yet attempted to measure sound potential; so we are probably delivered from an eighth!"

It is also maintained that, whenever work is done, there is, as matter of fact, an actual circuit set up, as much with steam and other forms in which energy is manifested as with electricity. Any one accustomed to think much upon natural methods and operations must concede this. Whenever work is done, something is taken temporarily from a general stock, to which it immediately returns after its service is performed. If it appear that something new has come into existence, we can make sure that in substance it is merely part of the stock from which we drew now diverted to some special function, distinguishable as an individual thing only till that function has been satisfied. Then it will go back into the general stock and complete its circuit, precisely as an electric current goes to earth and flows into the vast electric reservoir of our globe.

It is for these reasons that "the ideas of energy, work, and power which have proved so useful in the electric current seem to be equally applicable to steam or any other material current wherein potential runs through a cycle of changes."

Gas versus Electricity Direct from Coal.

MR. D. M. DUNNING, in his paper in THE ENGINEERING MAGAZINE for September, seems to have gained attention to his views in publications devoted to the interests of electricity, as well as in those published in the interests of the gas industry. *The Electrician* (London) antagonizes Mr. Dunning, taking issue with his proposition that, "if the direct production of electricity from coal were realized, . . . the electrician would only stand in this respect where the gas manager stands today," the latter producing energy direct from coal. To this and other criticisms made by the *Electrician*, the *Journal of Gas Lighting* replies editorially with so much force and pertinence that we cannot refrain from quoting the principal arguments in its well-written article (Sept. 22) entitled "A Fallacy Exposed." *The Electrician* said of Mr. Dunning's proposition, above quoted, that "we are constantly being reminded of those wonderful bye-products with the aid of which gas companies, if they had a mind to, could give their gas away without money and without price."

Whereupon *The Journal of Gas Lighting* replies that Mr. Dunning's remark is "so obviously true,—seeing that the cost of fuel in generating electricity, even by the present uneconomical method, forms so small a part of the total cost of the central-station unit,"—that it is rather surprising "to find *The Electrician* falling foul of Mr. Dunning for stating the fact," even to the extent of calling the idea underlying the erroneous statement of the critic "an ancient bogey." The *Journal of Gas Lighting* goes on to say that, "as a matter of fact, of course, not a single gas company has ever pretended that the return from residuals can enable gas to be supplied *gratis*. This is the popular misconception of the state of things created by the circumstance that some gas undertakings actually do pay for their coal, and all of them defray a substantial proportion of their coal bill, by means of the residuals of gas manufacture. It should not be necessary to inform an engir eer, however, even if he happens also to be an electrician, that there are manufacturing industries in which the net cost of the raw material forms only a small part of the total working expenses. It is so to some extent in gas manufacture, at any rate; and, it is very much more so in electric lighting."

Mr. Dunning said that even a carbon battery of 100 per cent. efficiency "would place electricity in no more favorable position with respect to gas-lighting than is held by the steam-and-dynamo stations of the present day." This the *Electrician* calls "palpably absurd," while *The Journal of Gas Lighting* says "that, so far from being absurd, . . . it is the merest commonplace," and the reason why *The Electrician* does not so see it, is that "modern steam-and-dynamo stations have an energy efficiency of not more than from 7 to 10 per cent., at their best load, and a considerably lower efficiency on the yearly average." It adds "that the corresponding truth is entirely overlooked that the whole cost of generating the unit by these inefficient machines bears no greater ratio to the commercial expenses of carrying on the electric-lighting business, if, indeed, it is so much." It therefore charges that Mr. Dunning's critic, "in thus confounding the independent matters of physical and commercial efficiencies, is lending countenance to the mischievous delusion that electric-lighting can be materially cheapened by getting the necessary steam for nothing, by the aid of refuse destructors. If it would not, could not, materially reduce the cost of the central-station unit of electricity, were the steam procurable for nothing, what difference could it make if the machinery were to be replaced by a battery yielding the electricity direct from carbon?"

"To give the dream of a carbon battery every advantage, our contemporary assumes that, if such a process of generating electricity were realized, 'the energy efficiency of an electric station could be raised tenfold, and its capital outlay and yearly expenses be enormously diminished.' Even if the former result were achieved, would the latter necessarily follow? Carbon-oxidizing batteries would cost something to begin with, and they would need housing and looking after, just as steam machinery does; and all the other expenses of carrying on the electric-lighting business—the distribution, the management, the administration—would be unaffected by any change in the method of generating. . . . The existing electric-lighting undertakings, at any rate, would not benefit much by the introduction of a new patent carbon-oxidizing battery of ideal efficiency."

Now, all of this may or may not be viewed as extreme on both sides. We are inclined so to regard it. The ideal carbon battery would work its revolution in other fields than electric lighting. Doubtless the cost of the latter would not be so much reduced as at first sight might seem possible, but that some material reduction would result can not, we think, be doubted. *The Journal of Gas Lighting* admits that some items, in the nature of fixed charges, would remain the same. This being the case, their percentage of the entire output would become smaller with increase of output. However the subject be regarded, Mr. Dunning may congratulate himself that his paper has not failed to produce an impression.

Insurance of Electric-Lighting Stations.

In this department for November we had something to say upon the subject of insurance for electrical plants. A large increase in insurance rates is now made the subject of considerable complaint in England, and has called forth an editorial protest from the *Electrician* (Oct. 30). This protest asserts that the advance in rates has aroused general indignation in the electrical fraternity, and that it is difficult to find any "justification for this augmentation of the burdens laid upon the shoulders of those engaged in the none-too-easy task of selling electrical energy at a profit." It asserts that the "small percentage of serious disasters has been confined to works fitted up during the pioneering days, when wood was regarded as the safest insulator."

A cause of complaint is also found in the treatment of electrical constructors by the surveyors of the fire offices.

"These surveyors are now not only experts in fire risks, but possess considerable knowledge of the technical details of electric-supply works. They frequently recommend alterations in fixtures or improvements in construction which may reduce fire risks; but, no matter what the cost of these alterations may be, the premium is not reduced,—occasionally it is even increased. Works recently fitted up with every improvement in design and construction, so as to render a serious fire absolutely impossible, are compelled to pay excessive premiums even on the full value of buildings and every item of plant. In vain are enormous sums expended on imposing-looking Clapham-Junction-like switchboards of enamelled slate or marble, secured on iron framing, or built in walls surrounded neither by wood nor any other inflammable material; the floor may be of stone or cement, free from culverts or conduits for mains, which may all be enclosed in iron pipes; the roof may be constructed with iron principals and purlins, and with neither roofing felt nor timber of any kind. all these precautions have been taken, yet nothing can save the insured from the exorbitant charges of the fire offices. The committee of the fire offices is, in fact, all powerful, and it is difficult to believe that the offices are in any way influenced by the reports of the surveyors, since these gentlemen cannot possibly be ignorant of the value of their own improvements. The electrical industry has good cause for complaint. Years of hard work have resulted in the successful utilization of capital; and it seems strange that the industry which has removed gas, paraffin lamps, and candles from a large percentage of houses insured should now be the sport of those who might reasonably be expected to give it every encouragement."

It is impossible not to recognize the force of this protest; but it seems that, unless an insurance trust has been formed in England which prevents its action, the general law of competition should soon put an end to the exaction of extortionate rates upon buildings which conform in all respects to underwriters' requirements. A properly-built, properly-arranged, and properly-managed electric-lighting station is not of necessity an extra-hazardous risk.

Small Block Stations versus Large Central Electric Stations.

One of the questions now before the electrical fraternity has come out of the progress made in the construction and operation of gas engines. It having been satisfactorily demonstrated that electric lighting can be successfully carried out with power derived from gas engines, it has come to be considered a possibility that smaller central stations, each supplying a comparatively small district, may prove more economical than the large installations now driven by steam power. In a recent number of *Dingler's Polytechnic Journal*, the affirmative of this question was ably argued by R. Knocke. *Progressive Age* (Oct. 15), in a number devoted almost wholly to gas and gas engines, makes liberal extracts from Herr Knocke's argument, which show that the affirmative side has many reasons to offer in favor of the smaller installations.

Of course, the whole matter simmers down to cost estimates and profits on capital invested. It is shown that the large installations yield a good income only when they supply from the outset a large number of consumers. Often, after the first two years, the income, which through installations has been fairly good, falls off, and it may be several years before a sufficient increase of consumption brings the income up to a satisfactory return.

The constant increase in number is attributed to the rapid improvement of gas engines, which have made the production of power from gas very economical. The case of two thirty-five-horse-power engines built by the firm of Gebrüder Körting of Körhugsdorf, near Hanover, and placed in a block station in Frankfort-on-Main, is cited as in point. These engines are of the single-cylinder type. The department of electrical tests determined the gas-consumption per horse-power hour to be an average of 17.52 cubic feet. The gas was taken from English gas works, and its mean calorific value was 565.5 B. T. U. per cubic foot.

Assuming that this measure of economy is attainable in any block station, and may be used in calculations of the power of gas engines, Herr Knocke proceeds to calculate the cost of an installation wherein the conditions obviate the necessity of a special system of feed-wires, and presents a detailed description of it. The figures of cost show a marked economy as compared with steam-driven installations. In conclusion the argument is summed up as follows:

"There have lately been many, in position to judge, who have predicted a great future for electric plants using gas-engines; Professor Slaby among others, whose authority is unquestioned, considers the use of gas-driven dynamos a most happy idea. These electric plants with gas engines present, moreover, the advantage of occupying but little space, and, furthermore, their efficiency is greater on account of the doing away with belts, and, finally, the reliability in working is greater on account of the direct coupling and the small circumferential speed of the armatures. The minimum cost of installation and operation, the simplicity of service, the avoidance of feed-water pipes and coal storage constitute still further advantages in favor of the plants; and, in short, the possibility of being ready for any emergency plays an exceedingly important *rôle*, taking into consideration the wide limits between which the demands of lighting vary. An installation supplied with gas-engines can meet easily any emergency, which is not the case with those using steam.

"Cities in which there is not as yet a central station, and, above all, those in which the gas works is operated by the municipality, have every reason for installing small 'block stations' with gas engines rather than large central stations with steam. As we have demonstrated above, these plants give a good income when the gas works is a private enterprise, and when gas can be purchased at net cost. Not only do these stations aid in the operation of the gas works, whose production they increase, and whose operation they render more regular, but the cities themselves are assured of a lasting income by the same utilization of the gas by means of the sale of the electric light. Through the competition of electricity, gas works are to-day working under greater disadvantages than formerly, since they are working on new paths in the introduction of heating and cooking by gas. The way that we are preparing in the preceding study will have, if it is engaged in, the advantage of conciliating opposite interests of gas and electricity; the interests of cities are also engaged, as, by the means that we have advocated, their gas works are assured of a good income, while responding to the present demand for electric lighting."

Two-way Tumbler Switch.

THIS device, recently brought out in London, is illustrated and described in *Engineering* (Aug. 21). Two-way switches are very convenient in many situations which will readily occur to electric engi-

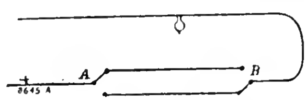


FIG. 1.

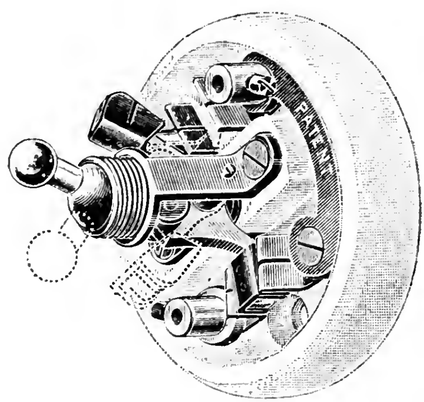


FIG. 2.

neers, and, for points where such a switch is wanted, the device here shown appears to have merit.

"In it a rigid metal rocker, furnished

with copper contact-pieces at each end, is pivoted between the usual uprights of a tumbler switch. The rocker is acted upon above by a vulcanized fiber roller in connection with the handle knob, and below by a powerful spring. Movement of the handle reverses the position of the rocker, allowing the current to pass into one or other of two circuits. One of the chief features of the switch is the exceedingly long break."

Two-way switches are useful whenever it is desirable to light or extinguish a lamp from either of two points,—say in halls, corridors, or bedrooms.

In diagram, Fig. 1, *A* and *B* are the switches, which may of course be placed where most convenient.

MR. HENRY S. CARHART (*The Electrical World*, Nov. 14), writing upon this subject, notices and criticises two articles that have recently appeared, one by Professor Ayrton and Mr. Cooper on "The Variations in E. M. F. of Clark Cells with Temperature," and another by Mr. W. Hibbert in the London Electrician on "A One-Volt Standard Cell." Professor Ayrton and Mr. Cooper, say "it has long been suspected that the lag of the E. M. F. of a Clark cell behind the temperature was due, not merely to the mean temperature of the cell itself lagging behind that of the bath, but to time necessary for the variations of the amount of crystals in solution, and for diffusion to take place." Mr. Carhart says that the use of the word "suspected" in this connection ignores much that has been written upon the subject, citing an article written by himself and printed in the *American Journal of Science* in July, 1893, as proof of his allegation. He asserts that a full volt standard has been ***in esse*** since the date named.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

LIGHTING.

*8681 Facts about the Electric Light. A. G. New and A. J. Mayne (The object of the paper is to place before readers, in simple language, a few leading facts about electricity as applied to the requirements of everyday life in order to remove the impression of danger, mystery and enormous cost). Ill Car & Build—Oct. 2. 2400 w.

*8689. Tests Made by Messrs. Korting and Mathiesen, Leutzsch-Leipzig, on the "Jandus" Arc Lamp (Light measurements which turned out very unfavorably to the "Jandus" lamp. Results given). Elec Rev, Lond—Oct. 2. 1600 w.

*8693. The Bristol Central Electric Lighting Station. J. R. Blaikie (Description dealing with the principles as compared with other electric lighting stations, drawing attention to characteristic features of the present plant). Elec Eng, Lond—Oct. 2. 2700 w.

8705. The New Congressional Library Building, Washington, and Its Lighting Plant. N. Monroe Hopkins (Brief illustrated description of this building with its substantial lighting plant). Elec Eng—Oct. 14. 1300 w.

8738. Termination of the Brush-Western Electric Double-Carbon Lamp Litigation (A victory for the Western Electric Co. Record of the case). W Elec—Oct. 17. 2200 w.

8775. Gas Engines in Central Electrical Stations. R. Knocke (Extracts from arguments as presented in "Polytechnic Journal of Dingler" favoring block stations with gas engines). Pro Age—Oct. 15. 3000 w.

8851. Incandescent and Arc Lamps for Electric Railway Circuits (Illustrated description of lamps adapted to railway circuits). Am Electn—Oct. 2200 w.

*8858. Working Alternators in Parallel at Hastings (A description of a successful switch used in working the Mordey alternators in parallel. The process explained). Eng, Lond—Oct. 9. 1800 w.

8965. The Luminous Fountain at the Millennium Exposition in Budapest, 1896. Josef Herzog (The origin of the project, how it was built, its special equipments and how it is operated). Elec Wld—Oct. 31. 2400 w.

8966. Electrical Effects in Political Parades (Illustrated description of luminous devices adapted for use in parades). Elec Wld—Oct. 31. 1900 w.

8974. The Moskowitz Independent System of Car Lighting by Electricity (Illustrated description of a system which seems to possess many practical advantages). Eng News—Oct. 29. 1200 w.

9085. Electricity at St. Elizabeth's United States Hospital for the Insane (Illustrated description of the uses made of electricity in this large institution). Elec Eng—Nov. 4. 2800 w.

*9134. Norwich Central Electric Lighting Station (Illustrated description). Elec Rev, Lond—Oct. 30. 2200 w.

*9144. Electric Lighting of Modern Office Buildings. William S. Monroe (The general principles of wiring are illustrated and explained and the advisability of making allowance for this branch of the building construction is presented). Arch Rec—Oct.-Dec. 3000 w.

POWER.

*8659. The Use of Electric Power in Small Units. Ill. William Elmer, jr. (A consideration of the conditions under which the employment of electric motors in small units may be advantageous to producer and consumer). Eng—Mar.-Nov. 4100 w.

8712. The New Station of the Long Island City Electric Illuminating and Power Company (Illustrated description). Elec Wld—Oct. 17. 600 w.

*8739. Alternate Current Station Switch Gear (Largely descriptive of an automatic non-return alternating switch designed by Leonard Andrews, of the Hastings Electric Light Co., Limited). Elec Rev, Lond—Oct. 9. 2300 w.

8746. Economic Use of Electric Power for Driving Tools. Reginald A. Fessenden (Read at the Sept. meeting of the Eng. Soc. of W. Penna. Things to be considered in arranging the system of power for a factory. Advantages of electric driving, cost, rate of production, &c., with general resume of results). Ir Tr Rev—Oct. 15. 3500 w.

8877. Direct Connected Engines for Electric Power Stations in Germany (Descriptions with illustrations of three engines recently installed in electric power stations in Germany. These will interest engineers in showing that the trend of practice in Germany is like that in America). Eng News—Oct. 15. 1500 w.

*8888. Designing a Bi-polar Drum Dynamo. Rankin Kennedy (Part first consists of statements preparatory to explaining and illustrating the processes generally used). Elec Rev, Lond—Oct. 16. Serial. 1st part. 700 w.

†8914. The Reconstruction of the Plant of the Chicago Board of Trade. Bion J. Arnold (Illustrated description of the general plan of the plant for producing light and power in building named). Trans Am Inst of Elec Engs—Aug. and Sept. 6000 w.

†8915. Present Status of the Transmission and Distribution of Electrical Energy. Louis Duncan (Full paper with discussion. Considers the different methods of transmission and distribution and the limits fixed by the present status of electrical development). Trans Am Inst of Elec Engs—Aug. and Sept. 12000 w.

8926. Electrical Devices for Changing the Speed of Series Motors. William Baxter, Jr. Showing how much variation in velocity is possible by the use of devices independent of the motor). Am Mach—Oct. 29. 1400 w.

*8944. Turbo-Electric Generators for Alkali Works (Illustration and description of one of two large generators constructed for the Electric Chemical Works of St. Helens, for the generation of electric current for the decomposition of salt into chlorine and caustic soda). Engng—Oct. 16. 500 w.

8955. Transmission of Niagara Power to Buffalo. Orrin E. Dunlap (Illustrated description of the construction of this line, now nearly completed). Elec Eng—Oct. 28. 2000 w.

9080. A New "Three-Wire" Dynamo. Alexander Rothert (Discussion of the new "three-wire" machine of the E. A. G., formerly W. Lahmeyer & Co., in Frankfort-on-the-Main). Elec Wld—Nov. 7. 1200 w.

TELEPHONY AND TELEGRAPHY.

8798. New Western Union Telegraph Offices at Buffalo. A. C. Terry (Illustrated description of the offices in the new Ellicott Square Building, which are considered among the finest in the United States). W Elec—Oct. 24. 1200 w.

*8823. Old Cable Stories Retold. F. C. Webb (A sketch of the laying of the Persian Gulf Cable of 1864). Electn—Oct. 9. 5000 w.

8852. American Telephone Practice. Kempster B. Miller (History and principles of the magneto telephone). Am Electn—Oct. 1800 w.

8866. Changes in the New York Telephone System (A review of the changes and the causes making it necessary to extend the capacity). Elec Eng—Oct. 21. 2000 w.

*8907. Thermostatic Fire Alarm Telegraphs. George Herbert Stockbridge (Illustrated description of automatic service). Elec, Lond—Oct. 9. Serial. 1st part. 1300 w.

*9028. Novel Application of the Loop Test. J. Rymer-Jones (Describes an expedient to meet a special emergency, of interest to electricians engaged in submarine repairs). Elec Rev, Lond—Oct. 28. 600 w.

9078. Experiments on the Theory of Telephonic Sound. Riugi Nakayama (Investigations from the point of electricity and from the point of acoustics—principally from the latter—and to find the requisites of a good transmitter). Elec Wld—Nov. 7. Serial. 1st part. 3200 w.

*9133. Veering Drums for Lightships (Illustrated description of invention of H. Benest for use in the problem of telegraphic communication with light ships). Elec Rev, Lond—Oct. 30. 900 w.

*9135. The Celebration of the Jubilee of the Electric Telegraph. M. J. Banneux (Address at the meeting of the Palais des Academies, in celebration of the establishment of the electric telegraph in Belgium. Historical Review). Elec Rev, Lond—Oct. 30. 4800 w.

MISCELLANY.

*8694. On a Complete Apparatus for the Study of the Properties of Electric Waves. Jagadis Chunder Bose (Illustrated description). Elec Eng, Lond—Oct. 2. 3000 w.

8706. Graphite from the Electric Furnace (Investigations of E. G. Acheson of the conditions under which graphite is formed in the carborundum furnace. Diagram is given with explanation). Elec Eng—Oct. 14. 1200 w.

8723. The Earth a Great Magnet. J. A. Fleming (Abstract of a lecture delivered to the workingmen of Liverpool on the occasion of the meeting of the British Assn in that city). Elec—Oct. 14. 1600 w.

*8744. Reostene; a New Resistance Metal. Dr. Harker and A. Davidson (Describes experiments made in a new alloy for commercial electrical resistances). Elec Eng, Lond—Oct. 9. 700 w.

*8745. The Division of an Alternating Current in Parallel Circuits with Mutual Induction. Frederick Bedell (Paper read before the British Assn at Liverpool. Mathematical, with diagrams). Elec Eng, Lond—Oct. 9. 1000 w.

8749. How to Check Station Instruments While on the Switchboard. A. O. Beneke (Directions, with precautions to be taken). Elec—Oct. 21. 1500 w.

*8822. On Criticism and on the Seat of E. M. F. in a Cell. Oliver Lodge (A criticism of Mr. Swinburne's second Canton lecture). Electn—Oct. 9. 1200 w.

8565. Charging for Electric Current on the Wright Demand System. How to Adjust Rates So that Every Class of Customer Shall Be Profitable to the Company. R. S. Hale (System explained). Elec Eng —Oct. 21. 2000 w.

*8889. On the Electrical Resistivity of Bismuth at the Temperature of Liquid Air. James De War and J. A. Fleming (Read before the Royal Soc. June 4, 1896. Describes experiments and gives results). Elec Rev, Lond—Oct. 16. 1000 w.

*8890. The Potential of Steam. Howard Pentland (A paper read before the Inst. of Civ. Engs., Ireland. The object is to show the electricians have no right to the exclusive use of the term "potential," and that it is a general conception concerned with all energy in whatsoever form it may be manifested). Elec Rev, Lond—Oct. 16. Serial. 1st part. 3000 w.

*8891. The Electrolytic Production of Potassium Percarbonate (Excerpt from account in Zeitschrift fur Elektrocheime to the effect that E. J. Coustam and A. von Hansen have succeeded in preparing a new salt of high theoretical interest). Electn—Oct. 16. 1500 w.

8964. On the Measurement of the Insulation Resistance of Street Railway Cables. Charles Hewitt (Describes a method of testing instituted by the author for the Electric Traction Co. of Philadelphia). Elec Wld—Oct. 31. 1300 w.

†8998. On the Induction Coefficients of Hard Steel Magnets. B. O. Peirce (A short account of the way in which deflecting magnets were made, with tables giving approximate knowledge of the induction coefficients of various makes). Am Jour of Sci—Nov. 2000 w.

*9027. Comparison and Reduction of Magnetic Observations (Report of a British Assn. Committee. Complete data as to the non-cyclic effects in the selected "quiet" days at Kew during the last six years). Electn—Oct. 23. 4400 w.

*9029. Apparatus for Eliminating Vibration from the Supports of Delicate Instruments (A statement of the principal features of an apparatus devised by W. H. Julius, of Amsterdam). Elec Rev, Lond —Oct. 23. 1000 w.

*9032. Lightning Conductors (A review of the present state of knowledge on this subject, with rules for the erection of conductors, which are said to be based on the highest scientific authority). Builder —Oct. 24. 4000 w.

†9043. On the Jacques Carbon Battery and on a Thermo-Tropic Battery (Discussion following experiments given by C. J. Reed at the meeting of the Electrical Section of the Franklin Inst.). Jour Fr Inst—Nov. 1200 w.

9059. Making Diamonds (An account of the address of M. Henri Moissau, delivered at the College of Physicians and Surgeons, New York, Oct. 27. Diamonds produced, quartz converted into vapor, and other remarkable results shown). Elec—Nov. 4. 2700 w.

9060. Modern Views of Electricity. Franz Dommerque (Abstract of a paper read before the Chicago Electrical Assn. Lines of work of various eminent electricians and theories advanced). Elec—Nov. 4. 1500 w.

9075. The Calibration of a Bridge Wire. W. M. Stine (Describes method, devised by the writer, aiming to give a simple, direct and accurate system). Elec Wld—Nov. 7. 700 w.

9079. Admittance and Impedance Loci. Frederick Bedell (A study of the relations arising from the reciprocal nature of admittance and impedance). Elec Wld—Nov. 7. 1300 w.

*9136. Contributions to the Theory of the Lead Accumulator (An account of rival theories of the reactions taking place in the ordinary lead accumulator). Electn—Oct. 30. 1200 w.

*9137. Dissipation Sheets and Wires (The behavior of a sheet or wire as an energy-dissipating apparatus is considered, but the article deals only with the care of sheets and wires of bare metal placed in a position such that equal radiation in all directions, and free but not forced connection, will carry away the heat energy). Electn—Oct. 30. 2100 w.

INDUSTRIAL SOCIOLOGY

Money and Prices.

THE leading article in *Gunton's Magazine* for November deals with what it calls a popular superstition, and holds that recent contention for free silver at the ratio of sixteen to one rests at bottom upon this superstition,—to wit, the belief that, "as government can fix the volume of money, it can also fix the price of commodities." Underlying the speeches of the free-silver presidential candidate, free-silver literature, and the platform of the Chicago convention is "the assumption that the value of all commodities is fixed by the volume of money." This is held to be "a remnant of the seventeenth-century doctrine that all prices or values are determined by the law of supply and demand." Of which doctrine it is affirmed that, "in proportion as economists have adopted inductive methods, this quantity theory has passed into decadence," together with "the old wages-fund theory," now also generally rejected by scientific economists, and "which was a part of this doctrine applied to wages." This doctrine, however, still retains its hold upon the popular mind.

Barker's "Bimetallism," recently published, justifies the assertions that this error is fundamental in the writings of free-silver advocates. It has been authoritatively declared that the struggle for free silver will be maintained; and, if this purpose be pursued, it will be fatal to the cause of sound money to permit any opportunity of resisting it to escape. Hence the argument against the propositions made on pages 17, 18, and 19 of Mr. Barker's book should be familiar to every one interested in the money question, which ought to mean every good American citizen. The propositions referred to are as follows.

"Commodities measure the price of money just as money measures the price of commodities. It follows of necessity that anything that causes money to appreciate must cause prices of commodities to fall, commodities measured in money becoming cheaper and money measured in commodities dearer. And so, inversely, anything that causes money to depreciate must cause prices to rise, for, the price of money in commodities falling, the price of commodities in money must rise." . . . .

"From the dawn of civilization down to 1873 . . . . prices have fallen and risen with a decreased and increased supply of gold and silver . . . . . But, when silver was discarded as a money metal, gold alone became the measure of value. . . . . . To make exchanges at the old level of prices, both gold and silver were required. But, silver being cast aside, the burden was thrown on gold alone. . . . . The demand was limited to the power of men to command gold, and, as gold was twice as dear, twice as hard to get as before, prices fell one-half."

Of these statements *Gunton's Magazine* says: "They contain the key to the whole free-silver doctrine." Their plausibility is admitted, but they will not stand the test of inductive verification. It is also conceded that John Stuart Mill, in his "Principles of Political Economy," admitted this view, but under the restriction that the ultimate regulator of the value of money is cost of production.* The truth of the assertion that prices advance or fall with increase or diminution of the volume of money is then tested by facts of record, and a similar test is applied to the oft-repeated assertion that the demonetization of silver in 1873 reduced prices fifty per cent.

In this connection a table compiled from the Senate Committe Report (Vol. 1, p. 9), the Journal of Commerce Year Book for 1896 (p. 88), and Treasury Circular 123 (p. 52) is presented. For each year from 1860 to 1895 inclusive, this table gives "the volume of currency in circulation,

* "Principles of Political Economy," p. 29.

the per cent. of increase, the population, the money per capita, the general average of prices, and the value of paper currency in gold."

Now, this table very clearly shows that there was a steady increase in the volume of money in circulation from 1860 to 1892, while in the same interval prices dropped an average of eight per cent.

"If we take the period from 1860 to 1873, we find the volume of money increased 72.6, and the average price of commodities 37.5; in other words, prices only rose a little over half as much as the volume of money was increased. In the period from 1873 to 1879 the volume of money increased 15.4 per cent., and prices, instead of rising, as they should have, according to the quantity theory, fell nearly 41 per cent., and from 1879 to 1892 the volume of money rose 179.7 per cent., while prices, instead of rising in the same proportion, fell about 4 per cent. It will thus be seen that the movement of prices has sustained no regular relation whatever to the volume of money. On the contrary, in 1864, 1865, and 1866 prices were double what they were in 1860, and more than double what they were in 1891, though the volume of money in 1864-1866 was a third larger than in 1860, and only half as large as in 1891-1892. The price column in the table shows that the rise of prices began in 1862, and more than doubled by 1865, but the entire rise disappeared by 1879. Why did the rise in prices come and go between 1860 and 1879? It was not because of the increase in the volume of money, for that was much greater after 1879 than at any time before. It was, as everybody now knows, chiefly due to the depreciation of the greenbacks, and this was not governed by the increased volume, but by the public confidence in the government's ability to keep its promise and redeem its notes in gold. With every victory of the northern arms the value of the greenbacks rose, and fell with every defeat. The fall in prices that took place from 1865 to 1879 was not because the volume of legal currency had been diminished, for it had been greatly increased; but it was because specie payments were resumed. In other words, it was the quality and not the quantity that affected the prices. The movement in the value of confederate currency from 1862 to 1865 is cited as another illustration that prices do not rise and fall with the volume of currency." Its value fell as the probability of success to southern arms declined.

Now, as to the assumption that "the act of 1873 cast silver aside and threw all the burden on gold," or "struck down half the money of the world," it is denied that any such thing occurred.

"The act of 1873 did not even stop the use of silver, to say nothing of striking it from circulation. Down to 1873, we had no silver currency. Nobody would take any silver to be coined, because it paid them better to sell it as bullion in the market, as it was worth nearly three per cent. more as bullion than as coin. We have now nearly five hundred millions of silver money in circulation doing the same kind of work as gold, all of which has been created since 1873. The second half of this proposition—namely, that 'prices were cut in two'—is a mere deduction from the assumption that half the money was struck down, neither of which has any foundation in fact. The only way any seeming case is made out on this point is by comparing the prices of 1873 and those of 1891 and 1892, which are the latest dates for which we have authentic facts. In doing this they make no mention of the fact that 1873 was about the middle of the inflation period and the prices quoted are greenback prices, and that the fall in prices from 1873 to 1879 was due to taking the inflation out of the greenbacks and establishing specie payments. The only legitimate period for comparison, therefore, is from 1879 to 1891, or from 1860–1861, before the greenback inflation began. In either case, by taking the general average of prices as expressed by the index numbers, which to the silverite is an infallible standard, instead of having fallen fifty per cent., as 'Coin' Harvey, Bryan, Barker, and others assert, prices have fallen less than ten per cent., and this, as we have already shown, can be fully accounted for by the economic causes affecting the production of the different articles, and cannot be explained by any change in the value of money, since the variation in prices differs with almost every commodity, some going up, some down, some not moving at all."

How the Protective System is Regarded in England.

AN article on the "Future of English Labor," in *Gunton's Magazine* for *November*, quotes a number of British newspapers, as indicating a trend of public opinion in the United Kingdom toward the abandonment of the policy of free trade and the adoption of a protective policy instead. "The relative decline of British trade, and the growth of outside competition, which has even resulted in foreign manufactured articles being sent into and sold in England itself, have formed," says the article reviewed, "the subjects of a large amount of economic discussion during the past few months."

We think this statement hardly expresses the real cause of the economic discussion referred to. There never has been a time when foreign manufactured articles were not sold in English markets. If anything is proved in the history of the world, it is that protective tariffs do not exclude foreign trade, unless they are made prohibitive in character, in which case provision for government revenues by special taxation must be made. But England has lately suffered to an unprecedented extent the effects of competition in her iron, cotton, and wool interests,—the industries in which she has reigned supreme,—and her tin-plate manufacture has received so severe a blow in the establishment of the tin-plate industry in the United States that doubtless many British economists are coming to think that free trade has exhausted its benefits for the United Kingdom, and that protection would now be a wiser policy.

The *Bradford Argus* is quoted as saying that, "in spite of the fact that Mr. Bryan is definitely pledged to a policy of free trade, whilst Mr. McKinley is as definitely pledged to protection, the general feeling in this district is in favor of the return of the latter. Had anyone predicted four years ago that it would be possible for the Bradford worsted industry as a whole, depending as it does so largely for its prosperity on a free entry to American ports, to be found arrayed on the side of McKinley and high protection, there would have been reasonable ground to express doubts as to his sanity. But, impossible as such a change of sentiment would have appeared four years, or even a twelvemonth, ago, it has actually occurred. Bradford wishes no evil to the United States, and Bradfordians would prefer to see a perpetual reign of McKinleyism—especially the McKinleyism as interpreted by the recent letter of the Republican candidate and the recent declarations of Republican newspapers—rather than see a people united to this country by so many ties of blood, tradition, and commerce plunged into the whirlpool of national disaster and national disgrace, which would infallibly be its fate if the people were foolish enough to adopt the policy of Mr. Bryan,—a policy as impossible of realization as it is crude and shallow in the theories on which it is based. We may even go further than this, and say that Bradford manufacturers as a whole approve on principle of the McKinley policy, as it has been interpreted by its author and some of the leading journals attached to his cause. That principle, as recently explained, does not embody the imposition of prohibitive duties, but such a tariff as will place producers in America on a fair footing with their competitors here, having regard to the higher rate of pay which prevails for most descriptions of labor on the other side of the Atlantic. It is to be a duty which will handicap British manufacturers to the extent of destroying any advantage which they may possess through cheaper labor, but not such as will interfere with 'keen and healthy competition' between the native and the imported goods. McKinley also recognizes in full the principle of reciprocity. We not only fail to see any just argument which can be urged against a policy honestly carried out on these lines, but it is such a policy as has often been advocated in these columns for the United Kingdom, and for the empire at large under the proposed imperial trade federation."

Bradford is one of the most important centers of the woolen and worsted industries. It is presumable that a paper published for and patronized chiefly by those interested in these industries voices the opinion of the majority of its readers.

Other papers—the *London Times*, for one—attribute the decay of British industries to the action of the trade unions. Among the industries so injured the glass manufacture is prominent. Firm after firm, it is alleged, is going out of business, while the country is flooded with continental glasswares. The *Pottery Gazette* confirms this, saying: "We do not hesitate to say that our British glass trade has been ruined by the action of the men's unions. . . . If it had not been for the blind policy of the men's societies, the pressed glass trade of the north of England would have found work for hundreds, where it now employs units. When our pressed-glass workers quarreled with their bread and cheese, orders for pressed goods went to Belgium and France, and they have gone there ever since. The bane of trade unionism, as far as the glass trade is concerned, has been the resolve of the leaders to keep up the rate of wages under all conditions. The object alike of employer and employed should be the retention of English industries in England herself. We have had instances of great national industries being lost to us by the attitude of the workers in them. Is the glass trade to be added to them?"

Upon all this the author of the article reviewed remarks: "It does not require much reading between the lines to get at the real meaning of this. True to her economic traditions, England's trade must be maintained, whatever becomes of her labor. When it comes to a conflict between the foreign market idea and the interests of home labor, the latter must give way. This is not the particular fault of English capitalists; it is a logical working-out of the inherent viciousness of the foreign market economic doctrine. In blind devotion to this theory the *Times* lays the blame for the present situation upon trade unionism and 'factory and educational legislation.' That is, the only logical remedy free trade has to offer is lower wages, longer hours, and restricted schooling for working children.

"England must be prepared for one of two things,—a readoption of protection, or a long and bitter struggle over the wages question, ending in a loss to her laboring class of a large part of all it has gained through years of joint sacrifice, agitation, and strenuous effort.

"What is true of England is equally true of the United States. Our wages are the highest in the world, and upon this basis our national prosperity rests. To secure the continuance of these conditions, the protective policy must be maintained."

Economic Aspects of Immigration.

FOR many years a constant influx of population differing in nearly all social respects from the native American population has been modifying the status of society and altering the conditions of labor in the United States. For many years no important protest against this immigration has been made. Tariffs intended to protect American industries have been imposed, and it has been claimed that these must maintain the wages of American workmen at a higher figure than can be paid for the same kinds of labor in Europe. At the same time hordes of immigrants have been permitted to supplant American workmen by the simple process of accepting lower wages. There is, however, now in progress a general awakening to the evils of unrestricted immigration, and definite and decisive action upon the subject cannot be much longer delayed. While a considerable part of the flow of foreign population to this country is of the least objectionable character, it cannot be successfully denied that the great and rapid increase of paupers, criminals, and tramps is due more to unrestricted immigration than to any other cause. The bulk of this influx, drawn from the lower and worst classes of society, brings with it ignorance, a dislike to the enforcement of law and order, and an utter disregard of the customs and manners of the people into which it comes, squalidly and disagreeably, as a disturbing element. It begins at once its competition in the labor market, abjectly accepting almost any wages that will enable it to crowd out the workers already engaged, and thus rob them of their places and livelihood. It is this which, more than anything else, has rendered futile efforts on the part of American labor to improve its condition.

In discussing this question, Mr. John A. Roebling, in *Gunton's Magazine* for October, takes the ground that "the whole question of the desirability, from an economic standpoint, of further large immigration" reduces to the question "whether high wages for the laboring class" are or are not "an advantage to the nation as a whole." No one will deny that high wages are beneficial to the wage-earner. "When his income is increased, his whole life is broadened and elevated. . . . Civilization and a considerable income are inseparable."

"But some one may say: This is all very true, and very trite. Every one desires every one else to have a large income, the larger the better; but where is it to come from? Higher wages mean either higher prices to the outside public, or else the ruin of the employers. In either case one class is enriched at the expense of another. Even though profits are excessive, possibly entirely unjust in some cases, it would be simply suicidal to drive all of the capital and talent for industrial leadership out of the country by such a policy. It would speedily reduce us to barbarism.

"This is an honest objection. It will occur to every one who candidly examines the question in all its aspects, and it should be honestly met. The underlying postulate of the argument is that a workingman can make only just so much in one day, and, if he should receive higher wages for it, that same amount of work must thereby become more expensive to some one else, either the general public or the employer."

An examination into the truth or falsity of this postulate shows that the higher-paid workman, considered merely as a producing machine, is the cheaper machine when measured by productive capacity. From this it follows that "we cannot afford to pay low wages. We cannot afford to let unrestricted immigration keep them low. For the sake of our own people, for the sake of those foreigners who are already here and under the protection of our flag, we must restrict immigration. And, if we are to remedy all these evils, it must be, not a half-hearted restriction of a few paupers or criminals or insane, but a drastic restriction of seventy-five per cent. of all immigration, that will, for some time to come, keep out all whose standard of life, and therefore of wages, is below the average standard of the American people."

The author sees no permanent safeguard against periodical panics or industrial depressions except in a gradual and permanent increase of wages, which the unrestricted importation of pauper labor from abroad obstructs, and will obstruct so long as it is permitted. It is shown that increase of our industrial power as a nation can go on successfully without immigration. To those who "insist that this country was destined as an asylum for the oppressed of all nations," it is answered that "our first duty is to care for those who are already here and under our protection."

The Foreign Market Delusion.

GUNTON'S MAGAZINE for October disputes the proposition "that a nation's industrial greatness depends upon the extension of its foreign markets." This is called an *a priori* assumption, a "doctrine essentially false," a "theory borrowed from the Manchester economics of a half century ago," and one that "could never have been evolved from any independent study of American conditions." The general proposition is thus narrowed down to a consideration of its applicability to the United States; the negative side of the question is argued from this standpoint, and recent comparisons between the exports of the years ending July, 1895, and July, 1896, showing increases in our exports, and anticipating the benefits to result (as recently made in the *Boston Herald*), are held to have no significance, as the increase "is scarcely more than normal, while the grand totals are far below those reached under the operation of the McKinley tariff of 1890." The argument from this opening proceeds to a comparison between home and foreign markets in their effects upon general industrial prosperity.

"Home markets are not only economically superior to foreign, because of their influence in binding together in a common interest all the industrial forces of the nation, but from now on they are certain to become, more and more, the chief markets which the producers of any country can rely upon. The world-wide extension of the use of machinery is fast doing away with the notion that any one country must, or can, even, be a workshop for all the rest. England is beginning to find this out already, as home manufacture in the colonies develops, and German competition becomes more aggressive.

"Even if the question of the location of a market, at home or abroad, were of no importance, the matter of its size certainly is. When this aspect of the question is considered, the utter folly of such figures as the *Herald's* is apparent. The immensity of the American home market and the insignificance of our foreign trade by comparison are manifest, from whatever situation the subject is viewed."

In 1889 the foreign market took of American products of agriculture, mines, forests, and fisheries 17 per cent. of the amount required for home consumption, while of manufactured products it absorbed only 1.4 per cent. Of products of all sorts it took only 5.6 per cent. The writer of the article under review claims that practically the same conditions existed in 1870 and in 1880. The exports, for 1870, 1880, and 1890, of agricultural products were respectively 15, 25, and 22 per cent. of the home consumption, while of manufactured products they were for the same years respectively 1.6, 2.2, and 1.4 per cent.

Further statistics are given relating to wool, corn, wheat, and oats, for the years 1890-94, which, it is claimed, "emphasize the fact that the hope of American farmers in the future lies in the continued growth of our manufacturing population,—that is, the non-agricultural,"—and that there is absolutely no opening for the American farmer abroad. It is concluded that, as compared with the American home market, "no other field of operations is worth considering," and that the "foreign market policy," instead of "containing the hope of a national greatness, has in it all the elements of national calamity, especially when sought by means of any sacrifice of the home market."

Industrial Progress in Japan.

THAT the industrial development of Japan is considered of the highest importance to the far-sighted men who are guiding the ship of State is indicated by the appropriations made by the diet during its recent session, a summary of which is presented in *Engineering* (London, July 17). The following sums were voted.

"(1) Improvement of the existing government railways, 26,553,000 yen, the payment to be extended over six years. (2) Extension of the telephone system, 12,802,106 yen, the payment to be extended over seven years. (3) Construction of a railway in Hokkaido, 1,178,313 yen, the payment to be extended over two years. (4) Construction of an iron foundry, 4,095,793 yen, the payment to be extended over four years. (5) New marine telegraph cables, 536,877 yen, the payment to be extended over two years. (6) Purchase of arms and ammunition, 9,258,088 yen, the payment to be extended over six years. (7) Manufacture of arms for the army, 6,486,766 yen, the payment to be extended over four years. (8) Manufacture of arms for the navy, 33,751,062 yen, the payment to be extended over six years. (9) Construction of ships for the navy, 47,154,576 yen, the payment to be extended over seven years."

The seventh, eighth, and ninth appropriations were universally denounced by leading statesmen not in the government and by the press, not for their exorbitance, but for their insufficiency.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines Reviews and Engineering Journals—See Introductory.

*8657. The Industrial Effects of Financial Isolation. Logan G. McPherson (Showing the inconvenience and danger to international trade presented by varying standards of value). Eng Mag—Nov. 3700 w.

*8702. Economic Aspects of Immigration. John A. Roebling (The principal propositions dealt with are, in brief, that high wages are necessary for general prosperity in the United States, and that we cannot afford to let unrestricted immigration force wages downward). Am Mag of Civ—Oct. 4000 w.

*8703. The Coming Struggle. Fred E. Tasker (The danger of centralized wealth is regarded as having brought us face to face with the preliminary contests of a great struggle which is to solve the critical problem of labor and capital, the mightiest that civilization has ever encountered). Am Mag of Civ—Oct. 5000 w.

†8803. Co-operative Distribution. Edward W. Bemis (A general account of co-operative societies, co-operative stores, and other co-operative movements and experiments). Bul of Dept of Labor—Sept. 15500 w.

†8804. Recent Reports of State Bureaus of Labor Statistics (Kansas, Montana, New Jersey). Bul of Dept of Labor—Sept. 2000 w.

8827. A Leap in the Dark—Being a Letter on the Silver Question. Thomas C. Clarke (Not a banker nor a "Wall street gold bug," but an old bridge builder and mechanic, having been requested to give his views on the silver question, herein points out the fatal consequences of tampering with the standard of value). R R Gaz—Oct. 16. 3000 w.

†8829. Nicaragua: Trade Routes, Railroad Enterprise, Coffee and Rubber Industries, &c (A mass of valuable commercial information is contained in the special report upon the topics named). Cons Rept—Oct. 13000 w.

†8835. German Law Against Dishonest Business Methods (Law which went into effect July 1, 1896, and whose provisions seem admirably calculated for the suppression of abuses in trade and of unfair competition). Cons Rept—Oct. 1700 w

†8837. Industries and Working People of Ghent (General description, with statistics). Cons Rept—Oct. 3000 w.

†8838. Vacation Colonies in Switzerland (General description of a system whereby poor school children needing recuperation are afforded vacations in the 'Ferien-Colonien," or vacation colonies). Cons Rept—Oct. 900 w.

†8839. German Trade in 1895 (An array of tabulated commercial statistics, with descriptive text). Cons Rept—Oct. 1000 w.

†8840. The United States Manufacturer and the German Market (More effort and the kind of effort needed to increase the trade of the United States with Germany). Cons Rept—Oct. 1400 w.

8867. Our Trade with the South American Republics (Editorial on the past, present and future work of the National Association of Manufacturers). Sci Am—Oct. 24. 900 w.

†8906. An Object-Lesson in Municipal Government. George F. Parker (Showing how public affairs are conducted in the city of Birmingham. A history of successful municipal government in which inefficiency has been converted into efficiency in the municipal conduct of affairs). Century Mag—Nov. 3000 w.

*8917. Japan as an Industrial Power. William Elliot Griffis (The progress and present industrial status of the country). Chau—Nov. 3600 w.

*8922. Tariff Changes and Customs Regulations (Russia, Germany, Belgium, France, Algiers, Portugal, Spain, Austria-Hungary, Roumania, United States, Costa Rica, Chili, China, Japan, Canada, Bahamas, Sierra Leone, Natal and Queensland). Bd of Tr Jour—Oct. 7500 w.

*8928. Popular Superstition on Money and Prices (Combats the belief—ranked as a popular superstition—that as government can fix the volume of money, it can also fix prices of commodities. Tabulated statistics are adduced to show that during a long period of currency expansion, prices of commodities steadily declined, thus opposing facts to the current belief). Gunton's Mag—Nov. 2800 w.

*8929. The Anti-Capital Crusade (The growing hostility to capital is herein characterized as an "economic malignity," and is strongly condemned as fraught with danger to the existing order of things). Gunton's Mag—Nov. 1500 w.

*8930. The Future of English Labor (It is stated as a matter of fact that England has gotten all the good she can out of the free-trade policy and is now leaning towards protection as a remedy for industrial decline. English papers are quoted in proof of the statement). Gunton's Mag—Nov. 2500 w.

*8933. The Saxon Land Credit System (The purposes and membership of this institution, together with remarks upon its loans, funds, debts, elements of safety, &c.). Gunton's Mag—Nov. 1500 w.

†9015. The Plain Truth About Asiatic Labor. John Barrett (While we have something to fear from Japanese competition the author does not foresee the ruinous effects predicted by some, and he endeavors to correct some false impressions that have obtained a degree of currency). N Am Rev—Nov 5000 w.

MARINE ENGINEERING

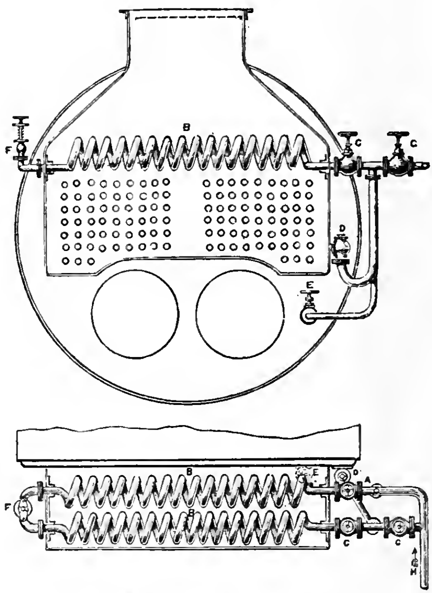
The Harman Feed-Water Heater.

THE simplicity and adaptability of this feed-water heater (herewith represented by a cut reduced from one in *The Engineer*, Oct. 16) will impress engineers at sight. The further points that merit attention are the ease with which it may be applied, not only to new boilers, but also to those already in use; its expansibility to compensate for differences in temperature; the small quantity of fitting and appurtenances needed for it; its evidently durable character; and its apparent efficiency.

It consists of two or more coils of copper pipe arranged in the smoke-box; the feed-water is passed through these coils on its way to the boiler, and the hot gases in the smoke-box surround them, the temperature of the feed-water being thus raised in proportion to the amount of surface given to the coils. It is said that these coils give no trouble and require little attention, and that the movement of the pipe in the coil, while contracting and expanding by heat, prevents scale from forming in the coils. The latter statement does not seem altogether credible, and the liability to scale seems to us the weakest point in the device. However, it would not be difficult to construct a smoke-box in such manner as to permit this heater to be taken out and put in when cleaning is needed, and the removal of scale from the interior of such a coil need not be a difficult matter.

In the engraving A is the inlet valve from pump; B B, heating coils; C, feed valve; D, check valve to boiler; E, circulating valve, with internal pipe to bottom of boiler; F, safety valve; G, intermediate valve; H, feed pipe.

We are also inclined to take with "some grains of salt" the statement that, in the case of the steamship Dione, fitted with this heater, the actual coal-consumption is reduced from 35½ tons to 31 tons, or about 12½ per cent. A reason assigned for this gain in economy over the theoretical is that the apparatus acts as a circulator; and some portion of the saving is probably due to its action in this respect; for, when fires are lighted in a cold boiler, or when fires are put away after being banked for some time, the coils commence to draw the coldest water from the bottom of the boiler through the valve, E, and deliver it again through the boiler check valve, D, at a high temperature.

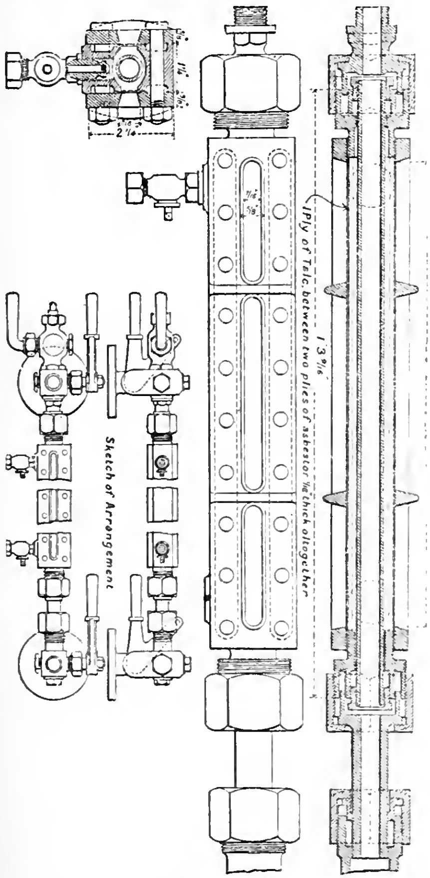


THE HARMAN FEED-WATER HEATER

It is said, in support of this claim and the reason assigned for it, that in half an hour after lighting one fire in one boiler of the above-mentioned steamer, and before the fire had entirely covered the grate bars, the temperature of the water at the outlet of the coils was 200 deg., and the rattling of the check valve showed the circulation to be most active.

A Balanced Water Gage.

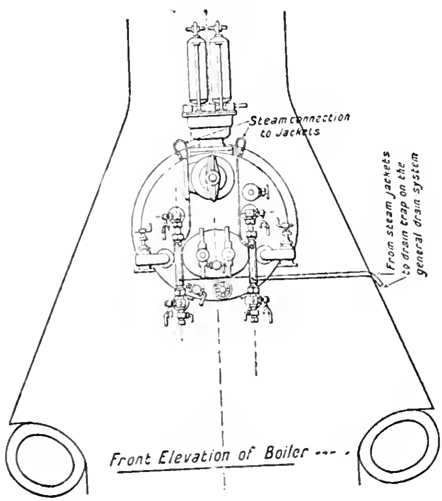
ONE of the practical annoyances that have attended the increase in working steam pressure has been the frequent breakage of water-gage glasses. A broken glass renders the gage useless, and yet the indications of the water gage are indispensable to the safe operation of a steam boiler. The breaking of the glass has even led up to serious accident, as was the case in the disastrous explosion on the British warship "*Blake.*" The substitution of talc for glass has proved that a transparent material capable of sustaining the required pressure exists; but, as talc soon blackens



BALANCED WATER GAUGE

and becomes partially opaque when in contact with boiler water, it is a very unsatisfactory substitute for glass, requiring a much longer time for renewal when discolored.

In a recent review (Department of Mechanical Engineering for Nov.), in which the limits of steam pressure were discussed, we spoke of the troubles experienced with water gages. We herewith present a condensed description, and reproduce on a smaller scale from *The Engineer* (London) the illustrations, of a new water gage. It is claimed for this gage that it obviates the difficulties attending the use of both glass and talc gages, and that it is entirely unbreakable. These claims challenge the attention of engineers because, if verified, a thing long and much wanted has been supplied. It is asserted that the problem has been solved by the use of both talc and glass in one and the same gage, the glass being exposed to the action of both water and steam, while the talc is acted upon by dry steam only, which does not affect its transparency as does the water. In other words, the glass water tube is steam-



jacketed by a larger talc case. The illustrations show how this conception has been carried out mechanically.

"The gage glass—connecting the steam and water in the usual way—is thus always in equilibrium, being enveloped with steam of the same pressure as that contained within it, and also protected from sudden changes of temperature, and, when once inserted in its fitting, it ought to last a long time. Above we give an outside view and a sectional elevation of the new gage, in which it will be seen that the fittings at either end of the gage glass proper, which connect it to the boiler front, are formed on the principle of a double stuffing-box, the exterior of the glass having an asbestos packing around it similar to that of an ordinary slide rod. This packing at either end is kept in place by a hollow cap or gland, and is thus prevented from detaching itself from the glass, and keeps a perfectly free and open passage right through it for the steam and water.

"The talc case surrounding the glass tube is supplied with dry steam from the boiler through a small cock at its top, while a similar cock at the bottom of the case is connected with an ordinary pipe draining into a small closed vessel, which may be emptied every watch, thus securing a dry atmosphere round the glass. The talc itself, never being in contact with the boiler water, remains transparent, and resists the highest steam pressure, thus making the gage impregnable to the usual trying conditions so detrimental to the ordinary gage glass, as high pressure, blows dealt inadvertently, cold currents of air, or water spray do not affect it. The packing at either end of the glass requires little setting up, and there is no tendency to leakage, although the glass is practically free.

"The fitting is slightly longer than the ordinary gage, to give the same visible range of water; but there is no need to provide for clearance above the cocks for inserting the glass, as the talc case can be removed at the front by simply slacking the coupling nuts, and any part can be tested or examined with the boilers at work. No objection can be raised to the jacketed tube, as, should the glass happen to break, steam and water are merely transferred from inside it to the outer case."

It is said that the English firm which has patented this gage and is beginning to place it on the market has tested it under 160 to 170 pounds' pressure, and will soon place it upon a number of high-class vessels. This being the case, the practical results will speedily show whether the water-gage difficulty has been eliminated, by this so-called "balanced steam gage," from the problem of working high-pressure steam.

We shall wait to see, hoping meanwhile for the success of the invention.

The Policy of the Victorious Party as Concerns American Shipping.

THE victorious party in the recent presidential election stands pledged to a policy of protection for American shipping. Whether or not this pledge shall be fulfilled, there will be an era of warm discussion upon proposed measures looking to its fulfilment. In fact, this discussion has already been active for a year or more in papers devoted to American maritime interests. As a contribution to the data necessary to the formation of an intelligent opinion upon the subject, the table on the opposite page, reprinted from *Seaboard*, and prepared by Mr. William W. Bates, ex-commissioner of navigation for the United States, will be useful. There is no doubt that many people who have postponed the consideration of this question till the election excitement should abate will now give attention to it. The party now coming into power must justify the hopes of the people in the fulfilment of its pledges, or expect overwhelming defeat in the next struggle.

Transatlantic Mail Service Time-Records.

A STATEMENT of time-records of ships carrying mails between New York and Paris, and between New York and London, prepared by Captain Brooks, superintendent of the foreign mail service in the New York general mail service, was printed in the *Iron Age* October 15. As it is an interesting statement in handy form for reference, and short, we quote it.

"American (New York to London *via* Queenstown and *via* Southampton).—'New York,' 15 trips, 172.1 hours; 'St. Louis,' 13 trips, 168.6 hours; 'St. Paul,' 10 trips, 169.7 hours; 'Paris,' 12 trips, 179.2 hours; 'Berlin,' 3 trips, 213.4 hours.

"Cunard (New York to London *via* Queenstown).—'Lucania,' 11 trips, 157.1 hours; 'Campania,' 12 trips, 158.1 hours; 'Etruria,' 12 trips, 169.5 hours; 'Umbria,' 13 trips, 174 hours; 'Servia,' 2 trips, 201 hours; 'Aurania,' 7 trips, 201.9 hours.

"Hamburg American (New York to London *via* Southampton).—'Fuerst Bismarck,' 7 trips, 170.3 hours; 'Normannia,' 7 trips, 174.7 hours; 'Augusta Victoria,'

OUR EXPERIENCE IN NAVIGATION AND THE BALANCING OF FOREIGN COMMERCE.

Statement showing the gain or loss of using our own Shipping or employing foreign in our Commerce. By William W. Bates, Ex-U. S. Commissioner of Navigation.

Year	American Shipping Per Capita, Hundredths of a Ton	Trade: Exports, Value Per Capita Dollars	Trade: Imports, Value Per Capita Dollars	Trn'sp'rtation Value by Am. vessels: Exports, per cent.	Trn'sp'rtation Value by Am. vessels: Imports, per cent.	Of Trade: Per Cap. Favorable, Dollars	Of Trade: Per Cap. Adverse, Dollars	Of Transportation, Exports: Favorable Dollars	Of Transportation, Exports: Adverse Dollars	Of Transportation, Imports: Favorable Dollars	Of Transportation, Imports: Adverse Dollars	Of Commerce as a Whole: Favorable Dollars	Of Commerce as a Whole: Adverse Dollars	Freights, Per Centage of Cargo value	Historical Notes
0	09.75	5.14	5.85	40	41	......	0.71		0.12		0.19	......	1.02	22 & 18	British and French at War.
1	09.81	4.68	7.19	52	58	......	2.51	0.04	......	0.21	......	......	2.26	......	Tariff raised 2½ per cent.
2	10.55	4.95	7.50	61	67	......	2.55	0.24	......	0.46	......	......	1.85	......	Algerine piracies begun.
3	08.96	6.03	7.21	77	82	......	1.18	0.97	......	0.87	......	0.66	......	25 & 20	Shipowning protected, 1789.
4	10.32	7.42	7.77	86	91	......	0.35	1.34	......	1.28	......	2.27	......	......	Tariff raised and extra duties by foreign ships.
5	12.03	10.48	15.23	88	92	......	4.75	1.99	......	2.56	......	......	0.20	......	
6	12.53	20.60	17.29	90	94	......	3.05	2.85	......	3.03	......	2.83	......	High	Shipbuilding protected, 1792.
7	12.45	11.70	15.54	88	92	......	3.82	2.25	......	2.61	......	1.04	......	rates	War with France.
8	12.06	12.30	13.70	87	91	......	1.40	2.27	......	2.25	......	3.12	......	thro'h	British banks all failed
9	12.63	15.27	15.35	87	90	......	0.08	2.43	......	2.45	......	4.80	......	this	Our commerce flourishing.
0	12.33	13.37	17.13	87	91	......	3.82	2.48	......	2.81	......	1.47	......	period	Peace with France.
1	11.26	17.06	20.19	87	91	......	3.13	3.15	......	3.50	......	3.52	......	......	"Napoleonic" wars continue.
2	09.74	12.71	13.39	85	88	......	0.68	2.22	......	2.03	......	3.57	......	......	War with Barbary States.
3	09.81	9.47	10.98	83	86	......	1.51	1.56	......	1.56	......	1.61	......	......	Our Navy begun.
4	10.82	12.78	14.00	86	91	......	1.22	2.30	......	2.29	......	3.37	......	......	Tariff and Tonnage dues raised.
5	11.81	15.23	19.22	89	93	......	3.99	2.97	......	3.30	......	2.28	......	......	British impressment begun.
6	12.28	15.69	20.00	69	93	......	4.31	3.06	......	3.44	......	2.19	......	......	British and French capture our vessels.
7	12.54	16.25	20.78	90	94	......	4.53	3.25	......	3.65	......	2.37	......	......	
8	11.09	3.27	8.31	88	93	......	5.04	0.62	......	1.43	......	......	2.99	......	Embargo act in force.
9	12.77	7.42	8.43	84	88	......	1.01	1.21	......	1.28	......	1.48	......	......	Non-intercourse act passed.
0	13.43	9.22	11.80	90	93	......	2.58	1.84	......	2.03	......	1.29	......	......	Culmination of tonnage per capita.
1	10.18	8.20	7.14	86	90	1.06	......	1.48	......	1.14	......	3.68	......	......	
2	09.78	4.99	9.96	80	85	......	4.97	0.75	......	1.40	......	......	2.82	......	War with England.
3	08.40	3.50	2.76	65	71	0.74	......	0.27	......	0.23	......	1.24	......	......	Much tonnage laid up.
4	08.17	0.84	1.58	51	58	......	0.74	0.01	......	0.05	......	......	0.68	......	Our harbors blockaded.
5	10.05	6.23	13.41	71	77	......	7.18	0.58	......	1.30	......	......	5.30	22 & 18	Peace with England. Free ship act.
6	09.12	9.45	16.97	68	73	......	7.52	0.75	......	1.40	......	......	5.37	......	Tariff act, moderate duties and flood of British goods.
7	08.94	9.84	11.14	74	79	......	1.30	1.04	......	1.16	......	0.90	......	......	
8	06.39	10.18	13.31	80	85	......	3.13	1.34	......	1.67	......	......	0.12	......	Tonnage decline, 2d free ship act.
9	06.08	7.47	9.27	82	87	......	1.80	1.05	......	1.23	......	0.48	......	......	British bank resumption.
0	05.95	7.23	7.72	89	90	......	0.49	1.30	......	1.11	......	1.92	......	......	American bank resumption.
1	05.88	6.52	6.29	84.8	92.7	0.23	......	0.90	......	0.97	......	2.10	......	......	Second packet line to Liverpool.
2	05.63	7.02	8.09	84.1	92.4	......	1.07	1.05	......	1.23	......	1.21	......	......	London and Havre lines started.
3	05.63	7.04	7.31	87.4	92.1	......	0.27	1.16	......	1.11	......	2.00	......	......	British W. I. ports opened.
4	05.79	6.09	7.37	88.7	93.4	......	1.28	1.19	......	1.15	......	1.06	......	......	Third free ship act. Tariff raised.
5	05.88	8.80	8.26	89.2	95.2	0.54	......	1.52	......	1.35	......	3.41	......	......	British W. I. ports closed again.
6	06.00	6.69	7.32	89.6	95	......	0.63	1.17	......	1.18	......	1.72	......	......	Culmination of our carriage.
7	05.87	6.92	6.68	87.5	94.3	0.24	......	1.11	......	1.07	......	2.45	......	......	Free-shipping policy in control.
8	06.18	5.91	6.71	84.5	91.4	......	0.80	0.89	......	0.99	......	1.08	......	......	Final act for unprotection of ships.
9	04.70	5.77	5.94	86	93	......	0.17	0.83	......	0.81	......	1.47	......	20 & 16	Tariff raised, 1828.
30	04.17	5.74	5.51	66.3	93.6	0.23	......	0.83	......	0.76	......	1.82	......	......	Hard times for shipping.
31	04.06	6.13	7.78	80.8	91	......	1.65	0.75	......	1.02	......	0.12	......	19 & 16	British W. I. opened again.
32	04.49	6.38	7.40	75.8	89.4	......	1.02	0.62	......	0.93	......	0.53	......	......	Tariff reduced.
33	04.63	6.40	10.66	75.5	90.7	......	4.26	0.62	......	1.38	......	......	2.26	......	Act for reduction of duties in 1836,'38, '40 and '42, to 20 per cent. horizontal.
34	05.18	7.21	7.47	74.4	89	......	0.26	0.66	......	0.93	......	1.85	......	......	
35	05.32	8.18	8.50	77.3	90.2	......	0.32	0.84	......	1.09	......	1.61	......	......	Falling prices.
36	04.95	8.41	12.41	75.4	90.3	......	4.00	0.81	......	1.60	......	......	1.53	......	
37	04.38	7.47	8.96	77.6	86.5	......	1.49	0.74	......	1.04	......	0.29	......	18 & 16	*Panic* and Suspension.
38	04.39	6.71	7.04	82.8	90.6	......	0.33	0.79	......	0.91	......	1.49	......	......	Commerce declined.
39	04.25	7.29	9.76	78.3	88.7	......	2.47	0.70	......	1.13	......	......	0.64	17 & 15	British Mail subsidy to Cunard.
40	04.48	7.15	6.28	79.9	86.6	0.87	......	0.78	......	0.69	......	2.34	......	......	Low tariff and revenue falling short.
41	04.48	6.93	7.28	77.8	88.4	......	0.35	0.65	......	0.84	......	1.14	......	......	Wildcat banking
42	04.53	5.78	5.53	76.3	88.5	0.25	......	0.51	......	0.64	......	1.40	......	......	Tariff raised. Resumption
43	04.36	5.36	3.47	77	77.1	1.89	......	0.49	......	0.28	......	2.66	......	9 mos.	First British Chinese war
44	04.66	5.78	5.68	70.5	86.7	0.10	......	0.40	......	0.62	......	1.12	......	......	Times improving.
45	04.54	5.33	5.75	75.8	87.3	......	0.42	0.63	......	0.46	......	0.67	......	17 & 15	Annexation of Texas.
46	04.60	5.34	5.75	76.2	87.1	......	0.41	0.47	......	0.64	......	0.70	......	......	Tariff reduced.
47	04.96	7.42	5.77	65.3	77.2	1.66	......	0.36	......	0.44	......	2.46	......	16 & 14	First American Steamers subsidized
48	05.28	6.33	6.80	71.1	82.9	......	0.47	0.41	......	0.62	......	0.56	......	......	Gold mining activity booming
49	05.62	6.25	6.28	68.9	81.4	......	0.03	0.37	......	0.55	......	0.89	......	......	British free ship act passed.
50	06.23	6.22	7.48	65.5	77.8	......	1.26	0.31	......	0.54	......	......	0.41	16 & 13	American Clipper ships preferred.
51	06.47	7.88	8.79	69.8	75.6	......	0.91	0.50	......	0.60	......	0.10	......	......	American steam lines running.
52	06.93	6.74	8.37	66.5	74.5	......	1.63	0.33	......	0.50	......	......	0.80	15 & 12	British subsidies advanced.
53	07.50	7.95	10.30	67.1	71.5	......	2.35	0.43	......	0.57	......	......	1.35	16 & 13	Crimean war to 1856.
54	08.18	8.97	11.27	69.3	71.4	......	2.30	0.56	......	0.62	......	......	1.12	......	British Lloyds prefer iron ships
55	08.63	8.04	8.47	73.8	77.3	......	1.43	0.61	......	0.67	......	......	0.15	......	British subsidies help steam.
56	08.19	10.01	11.05	70.9	78.1	......	1.04	0.67	......	0.87	......	0.50	......	......	Second British war with China.
57	07.83	10.14	12.02	60.2	71.8	......	1.88	0.29	......	0.58	......	......	1.02	14 & 11	Tariff reduction and *Panic*.
58	07.72	9.09	8.79	75	72	0.30	......	0.51	......	0.39	......	1.20	......	13 & 10	American subsidies withdrawn, and our steam lines ruined
59	07.58	9.55	10.81	69.9	63.7	......	1.26	0.48	......	0.29	......	......	0.49	......	
60	07.68	10.60	11.24	69.7	63	......	0.64	0.54	......	0.29	......	0.19	......	......	France and Austria at war.
61	07.76	6.78	8.98	72.1	60	......	2.20	0.35	......	0.18	......	......	1.67	......	Civil war—High tariff acts.
62	06.62	5.73	5.75	54.5	44.8	.04	......	......	0.06	......	0.07	......	0.09	......	Bank suspension—Many ships sold abroad.
63	05.75	6.07	7.25	40	43.3	......	1.18	......	0.16	......	0.10	......	1.44	......	
64	04.35	4.64	9.25	30	24.6	......	4.61	......	0.24	......	0.47	......	5.32	......	Confederate Cruisers sinking ships.
65	04.36	4.76	6.85	26.1	29.9	......	2.09	......	0.29	......	0.28	......	2.66	......	Civil war ended.
66	03.91	3.82	12.24	37.7	25.1	......	2.42	......	0.31	......	0.61	......	3.34	......	Prussia and Austria, France and Mexico at war. Culmination of effort to restore our ships.
67	04.18	8.13	10.93	39.1	28	......	2.80	......	0.21	......	0.43	......	3.44	12 & 9	
68	04.06	7.62	9.66	36.8	33	......	2.04	......	0.21	......	0.30	......	2.55	......	
69	03.97	7.58	11.06	34.9	31.3	......	3.48	......	0.27	......	0.37	......	4.12	......	Desperate work of rivals.
70	03.78	10.16	11.28	37.7	33.1	......	1.10	......	0.32	......	0.38	......	1.80	13 & 10	
71	03.45	11.12	13.15	32.6	31	......	2.03	......	0.50	......	0.50	......	3.03	......	British Lloyds degrade our ships, to increase British carrying.
72	03.37	10.94	15.43	29.8	26.8	......	4.49	......	0.62	......	0.71	......	5.82	14 & 10	
73	03.33	12.51	15.40	25.7	27	......	2.89	......	0.85	......	0.71	......	4.45	......	France and Germany at war.
74	03.27	13.70	13.25	24.8	30.2	0.45	......	......	0.97	......	0.53	......	1.05	......	Bank contraction and *Panic*.
75	03.48	11.68	12.12	23.7	29.2	......	0.44	......	0.86	......	0.50	......	1.80	......	American Steam to China and Japan.
76	03.36	11.97	10.21	25.4	30.8	1.76	......	......	0.77	......	0.35	0.64	......	13 & 9	Development. Pacific Ocean trade.
77	03.41	12.99	9.73	23.7	31.5	3.26	......	......	0.89	......	0.32	2.05	......	......	Treaty with Sandwich Islands.
78	03.36	14.60	9.18	22.6	32.2	5.42	......	......	1.04	......	0.29	4.09	......	......	Steam to W. I. and Mexico.
79	03.00	14.54	9.12	17.6	31.6	5.42	......	......	1.24	......	0.20	3.98	......	......	Contraction for *resumption*.
80	02.62	16.66	13.31	13.7	22	3.35	......	......	1.69	......	0.74	0.92	......	14 & 10	Foreign steamers increased.
81	02.52	17.58	12.52	13.3	19.9	5.06	......	......	1.95	......	0.75	2.36	......	15 & 10	Resumption accomplished.
82	02.39	14.29	13.80	12.8	19.2	0.49	......	......	1.49	......	0.85	......	1.85	14 & 10	California grain trade increasing.
83	02.35	15.34	13.50	13.4	20.7	1.84	......	......	1.57	......	0.79	0.52	......	......	French bounty to shipping.
84	02.31	13.48	12.16	14.4	22.4	1.32	......	......	1.34	......	0.67	0.69	......	......	Tariff reduction.
85	02.23	13.21	10.28	13.7	21.3	2.93	......	......	1.34	......	0.59	1.00	......	......	Germany and Italy, subsidy and bounty ship protection.
86	01.71	11.84	11.07	13.6	20	0.77	......	......	1.12	......	0.60	......	0.35	13 & 9	
87	01.67	12.20	11.79	12.2	18.6	0.41	......	......	1.18	......	0.66	......	1.43	......	British Admiralty subvention to steamers.
88	01.52	11.60	12.07	11.79	16.5	......	0.47	......	1.15	......	0.70	......	2.32	......	Foreign steam now well protected.
89	01.58	12.11	12.15	11.62	17.08	......	0.04	......	1.20	......	0.72	......	1.96	......	Congress neglecting ours.
90	01.47	13.69	12.60	9.04	16.68	1.09	......	......	1.57	......	0.84	......	1.32	14 & 10	Tariff regulated and lowered.
91	01.54	13.82	13.20	9.26	16.85	0.62	......	......	1.58	......	0.90	......	1.86	......	Large export of *Gold* to balance foreign trade.
92	01.43	15.75	12.65	8.11	17.66	3.10	......	......	1.98	......	0.83	0.29	......	15 & 10	
93	01.32	12.70	12.96	8.79	15.45	......	0.26	......	1.36	......	0.80	......	2.42	13 & 9	Export of *gold* and *Panic*.
94	01.31	13.07	9.60	8.74	19.43	3.47	......	......	1.29	......	0.47	1.71	......	12 & 8	Tariff reduction. Heavy exports of *gold*. Revenue deficient, deep business depression from adverse balances of trade, *gold* exports, and the want of shipping of our own.
95	01.18	11.60	10.51	8.22	15.48	1.09	......	......	1.16	......	0.58	......	0.65	......	
96	01.15	12.40	10.96	8.56	15.76	1.44	......	......	1.23	......	0.60	......	0.39	......	
97	......	......	......	......	......	......	......	......	......	......	......	......	......	......	
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Computed and closely approximated from the best information obtainable.

Practical Remarks.

In commerce, a ship serves two purposes: First, that of transportation for the merchant; second, that of earning and saving for its *nation* a competence of wealth and power. The merchant's use of shipping is beneficial, but the national service is invaluable—first, in balancing foreign trade; second, in creating means for maritime defence.

A shipless nation is always in foreign debt. Its exports and imports may balance, while its commerce, as a whole, is shortcoming, the balance to be paid in coin. The explanation is this: Commerce consists of *transportation* as well as *trade*. One is a complement of the other. The charge for freight follows the cargo; it is a virtual export or import, as the case may be. By our own ship abroad, it increases our credit there. By our own vessel home, it saves debt here. Thus transportation must needs be balanced, as well as trade; either by trade itself, by transportation, or by exports or imports of precious metals.

Where alien merchants, underwriters and bankers, as well as foreign vessels, are employed in a nation's commerce, *as now in ours*, only a very large excess of exports over imports can, or will, prevent an adverse balance of commerce. Insurance and commissions, profits and freights, have countervailed the largest balances of trade. Only the poor or slack among the nations have ever tolerated a passive commerce in foreign hands and ships. Every power in Europe, from Great Britain to little Portugal, is paying out money to maintain at least a [illegible] *marine*.

Until the year 1874 our balances of trade, with few exceptions, were adverse. Our commerce began with adverse balances, foreigners, then as now, largely carrying and controlling it; but *protection* to our *navigation* soon gave preponderance to our carriage, and changed balances from adverse to favorable down to the war—1861. In 1811 we first had a favorable balance of trade. Of 21 prior adverse balances, 16 were converted into favorable for *commerce*. In the period while our carriage preponderated—1791 to 1861—for 71 years—we had 59 adverse balances of trade, of which 47 were converted into favorable balances of *commerce*. When our carriage failed to convert, it was owing to a state of war, to tariff changes, or low duties. Where unconverted, adverse balances were minimized. The adverse and the favorable balances in the 71-year period sum up to $119,701,656, and to $807,481,210, respectively, or as *one to two*, greatly to our advantage.

For the last 35 years the balances of transportation have all been adverse. Beginning at $4,277,000, in 1862, they enlarged annually and reached $183,782,430, in 1892. For the period they aggregate $2,878,518,913; and in the last 7 years have averaged $144,159,581. In the 35 years we had 20 favorable balances of trade, but 9 of these were changed to adverse, and our favorable balances of commerce cut down to 11, as against 24, in spite of *ample exports* and the *high tariff* prevailing. The result for the period is an adverse aggregate balance of commerce of $1,674,572,921, converted from a favorable balance of trade of $1,203,945,992, making a loss of $2,878,518,913, by foreign carriage—a waste of wealth at once needless, exhausting and dangerous.

7 trips, 178.1 hours; 'Columbia,' 6 trips, 177.1 hours.

"White Star (New York to London *via* Queenstown).—'Teutonic,' 13 trips, 170.2 hours; 'Majestic,' 12 trips, 173.6 hours; 'Germanic,' 11 trips, 197 hours; 'Britannic,' 13 trips, 210.4 hours; 'Adriatic,' 2 trips, 232.3 hours.

"North German Lloyd (New York to London *via* Southampton).—'Havel,' 12 trips, 184.6 hours; 'Lahn,' 10 trips, 183.1 hours; 'Aller,' 9 trips, 190.5 hours; 'Spree,' 12 trips, 186.1 hours; 'Trave,' 8 trips, 191.5 hours; 'Saale,' 9 trips, 196.3 hours; 'Ems,' 5 trips, 199.7 hours; 'Fulda,' 4 trips, 201.2 hours; 'Kaiser Wilhelm II,' 1 trip, 219 hours; 'Werra,' 1 trip, 226.7 hours.

"Générale Transatlantique (New York to Paris *via* Havre).—'La Touraine,' 10 trips, 186.3 hours; 'La Bretagne,' 6 trips, 194.1 hours; 'La Bourgogne,' 12 trips, 199.5 hours; 'La Champagne,' 7 trips, 196.9 hours; 'La Gascogne,' 10 trips, 200 hours; 'La Normandie,' 7 trips, 201.6 hours."

Copper Sheathing of Cruisers.

THE advantages of copper sheathing for iron hulls are now recognized. The value of copper on wooden hulls is not alone in protection from the teredo, but also in a large reduction in expense for docking and cleaning. The latter advantage pertains to the use of copper sheathing on iron hulls. *Practical Engineering* (Oct. 9) quotes the *Naval and Military Record* as stating that the results of experience with cruisers prove the usefulness of sheathing their under-water structure.

"The latest convert to this process is the United States, whose naval authorities have been collecting information as to the advantages of sheathing their cruisers with wood and then covering them with copper, to obviate the necessity of frequent docking for cleaning the hull. With an ordinary steel hull it is found that, after five or six months afloat, one-fifth more power is required to maintain ordinary cruising speed than when the bottom was clean. In considering copper and wood sheathing, the fact must not be overlooked that the former process is the more costly.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*8662. Absence of a Standard in Battle-Ship Design. Ridgely Hunt (A comparison of the navies of the world with regard to size, gunpowder, armor, speed and coal capacity). Eng Mag—Nov. 3700 w.

*8668. Torpedo-Boat Destroyer "Entre Rios" (Illustrated description). Engng—Oct. 2. 700 w.

*8673. H. M. S. First-Class Cruiser "Powerful" (Illustrated description). Eng, Lond—Oct. 2. 1300 w.

8707. The New Steamship "La Grande Duchesse" (Illustrated description). Eng —Oct. 10. 1000 w.

8708. Our Experience in Navigation and the Balancing of Foreign Commerce. William W. Bates (Tabulated statement showing the gain or loss to the United States by using American shipping or employing foreign vessels in its commerce). Sea—Oct. 8. 800 w.

*8752. New Steam Launch for the Ambulance Service of the Metropolitan Asylums Board (Illustrated description of an ambulance boat designed and built for river ambulance service). Ind and Ir—Oct. 9. 1500 w.

8777. A Warship Run by Air (Reprinted from "N. Y. Evening Post." Description of compressed air machinery for steering, turning turrets, working guns, &c., of the U. S. monitor "Terror"). Com Air—Oct. 1300 w.

*8943. Torpedo-Boat Destroyer "Capitan Orella" (Illustrated description and comments). Engng—Oct. 16. 1200 w.

*8954. H. M. S. "Powerful" (Description of second set of trials with editorial comment). Eng, Lond—Oct. 16. 2300 w.

*8994. Engines of Torpedo-Boat Destroyers "Salmon" and "Snapper" (Illustrated description). Engng — Oct. 23. 900 w.

*9017. The North of England Shipbuilding Industry. Henry F. Swan (Extracts from a presidential address delivered before the Northeast Coast Inst. of Engs. Review of the past and present of the industry. The tendency to increase the size of vessels and the increase of steam pressures are particularly noticed). Col Guard—Oct. 23. 3500 w.

9076. The Electric Yacht "Utopian" (Illustrated description). Elec Wld—Nov. 7. 1200 w.

*9116. The Engines of H. M. S. "Diana" (Illustrated description). Engng—Oct. 30. 1000 w.

MECHANICAL ENGINEERING

Liquid Fuel for Steamships.

THE advantages that would attend the successful use of liquid fuel for marine propulsion are so great and obvious that, notwithstanding the repeated failures which have attended experiments in this direction, inventors are still grappling with the problem. We believe complete success will ultimately reward this persistence, and deem it highly probable that the present generation will see the use of liquid fuel fairly inaugurated.

As all liquid fuel has either to be atomized, or gasified, in order to burn it, these method appears to be the only approaches to a practical solution of the problem. For the larger installations atomizing has had the preference hitherto.

Nearly all the great naval powers have been experimenting with liquid fuel for marine propulsion. Progress with stationary oil engines on land has been rapid but it is not generally known how far the use of oil fuel has progressed for railway and marine purposes. This article will present an outline of progress in these directions.

Russia is using liquid residues from the distillation of petroleum on more than seventy-two locomotives. England recently adopted liquid fuel for one of its torpedo boats, now completed, which is provided with oil storage tanks in place of coal bunkers. Most of the Russian cruisers are fitted for burning liquid fuel. Last, but not least, the United States government, if current reports may be credited, has found in an invention of Mr. J. S. Zerbe a successful method of using oil as fuel for marine purposes; so that, perhaps, we ought to admit that the use of oil as fuel is already fairly inaugurated.

But there still remains the question of the supply. For general use oil must be at least as cheap per h.-p. hour as coal. For marine purposes, such as passenger steamers and war-ships, its advantages will more than balance a considerable difference in cost; but who can now say precisely what that difference will get to be in the course of a quarter of a century? It is true that new supplies are from time to time discovered; but the consumption for all purposes increases annually, and, unless the earth is a huge manufactory of petroleum, the time must come when all supplies will be exhausted. The extent of petroleum deposits cannot be estimated as well as that of known coal deposits, and, while there are large stores of mineral oil in the earth's crust, it is easy to conceive of a growth in demand that would double present prices. Nevertheless, the use of oil as fuel would still obtain for all purposes wherein its advantages counterbalance its increased cost; and, as we do not now perceive such advantages in its use for stationary and locomotive engines, we are inclined to the belief that its employment for these purposes will not be maintained for a very long term of years, except, perhaps, in some special service. This, of course, implies our belief that the oil-supply is not likely to meet a general demand for oil fuel at a sufficiently cheap rate.

In connection with this aspect of the subject, an editorial review of the world's oil-supply in *Engineering* (London, Oct. 30) is of interest. It says:

"The United States and Russia are our great sources of supply; the former last year produced 53,000,000 barrels of 42 gallons, and the latter 38,333,000 barrels, and carefully-compiled statistics fail to account for more than 95,000,000 barrels as the world's production; but there is no doubt that much oil found is used locally, and therefore not accounted for. Austria-Hungary gives 1,250,000 barrels; Canada, 802,574 barrels; India, 295,994; Java, 293,-654; while Peru, Roumania, Germany, Japan, and Italy are amongst the other producing countries. Great Britain's quota, if we exclude the two million tons of shale oil, is inappreciable.

"That the supply is scarcely equal to the demand is in some measure indicated by the continued high level of rates. The output in the States, especially in Ohio, Indiana, and California, shows a great increase. Only once, in 1891, has the total been greater than that for 1895, already given, and withal stocks have greatly decreased. In the great Appalachian oil-field, producing 31,000,000 out of the 53,000,000, the stocks only include 5,333,000 barrels. Thus prices have increased. Indeed, the average is higher than in any year since 1877, and the lowest rate last year was above the highest reached in 1894. The average price was 5s. 7½d. per barrel of 42 gallons in the Appalachian district, while over all the price was 4s. 2½d., against 3s. in the previous year. Of course the price of oil is often artificial, due to market manipulation, especially in the States, but there has been no appreciable difference in prices in countries where such influences are not at work.

"We have given the production in the States; and, as to the prospects of increased supply, some interesting points are brought out in a recent report made to the geological department by Mr. Joseph D. Weeks. Between twenty and twenty-five promising wells have been sunk in the Appalachian field, two yielding about 6,000 gallons per day. In the Los Angeles district of South California there has been great extension, the total having trebled in three years. In Wyoming also there is increased activity, but the difficulty is the absence of means of cheap transport. The oil has to be hauled fifty miles in road wagons; but Mr. Weeks predicts that, with facilities to operate, 'it would be only a short time until the excitement of early days in Pennsylvania would be duplicated.'

"It is, however, from Peru that the greatest augmentation of supply may be anticipated. The principal field is in the department of Piura, and estimates have been made as to the area yielding petroleum, one of them putting it as high as 7,200 square miles. Since the Pennsylvanian field is only 350 square miles, and in thirty years has given forth 516,000,000 barrels, the prospects for Piura seem bright. Energy, it is said, is alone required. The crude petroleum contains 84.9 per cent. of carbon, 13.7 per cent. of hydrogen, and 1.4 per cent. of oxygen. The oil wells generally need to be 800 feet deep, although it has been struck at 30 feet, and the maximum seems 1,200 feet. The cost of a well 1,000 feet deep is put at about £500; 20 large wells would supply a refinery, and the cost of such an establishment would be £20,000. Of 49 wells bored since 1892, 44 have been productive, and some of them yield 30,000 gallons per day. A London company has been working some of the wells, and the imports of oil have decreased to one-third the volume of 1889, the price of the local oil being one-third that of North American petroleum. Crude oil, too, is being used on the locomotives on all the Peruvian railways, in several manufacturing establishments, and in the gas works.

"In Russia 269 new wells were drilled last year, 133 being deep wells, the average depth of all being 540 feet. This is a higher mean than usual, and in six years 1,371 wells have been drilled. The average number in operation now is 622, producing, as we have already stated, 38,000,000 barrels, of which 26,000,000 are pumped, the remainder flowing freely. The pumps consist of buckets worked by windlasses, and bring at each stroke a barrel of crude oil. The total output has been steadily increasing. In 1889 there were 278 wells, yielding 20,000,000 barrels; now 622 wells yield 38,333,000, so that there has been a slight decrease in the average yield per well."

Charging Cupolas.

SOME practical hints upon this subject contributed by Mr. E. Grindrod to *The Foundry* for September are worth considering, though doubtless they will not be new to skilful foundrymen. The management of the cupola is one of the nice points in foundry economy, often determining the success or failure of a day's melt, even if not in the end determining the success or failure of the foundry itself. Too often the charging of the cupola is done in so heedless a way that castings are ruined that otherwise would have turned out well. We can remember an instance where three successive engine cylinders were spoiled in the foundry by mixing into the charge fragments of scrap containing brass bolts, the zinc in which alloyed with the iron in spots that would take the edge off the best tools used in fitting. This was an instance of gross carelessness in the management of a large establishment. If such things are possible in a large establishment, they are perhaps more liable to occur in smaller ones, though this does not logically follow.

Mr Grindrod evidently does not rely upon the blast-meter as a sure guide to all that goes on in a cupola, and believes in the capacity of the latter to tell its own story, provided the foundry foreman is competent to understand it, when told. He believes "the cupola should be consulted before the meter."

"The cupola will melt the same one day as another, providing the conditions are the same, and the secret of successful cupola management is to make the conditions as nearly alike as can possibly be done by mixing heavy and light irons so that they will be nearly the same for one day as another,—not by picking out all the small iron first, and leaving the heavy pieces to accumulate until all the small scrap is gone, and then being compelled to use the heavy scrap all at once, so that any one not thoroughly up in the cupola business may have trouble in melting iron. In charging a cupola it is very necessary that the proper amount of kindling wood and heavy wood be used to get the coke burning briskly, and the cupola tender should not put on too much coke at the start, but keep adding the bed coke as the cupola burns through, keeping enough coke back to level up the bed before charging. Another important factor in cupola practice is that the bed coke and the first two charges ought to be picked coke; that is, no small coke should be charged until the third charge. This keeps the tuyeres clean by keeping the melting point at a sufficient height above the tuyeres so that no pieces of iron can get down to them before being thoroughly melted."

With reference to reliance upon blast-meters, the author narrates an episode that throws some light upon what may take place in a cupola, even when provided with a good blower. The cupola of the shop in which the episode occurred had a No. 8 Sturtevant blower.

"We had tried to take off a heat every day for six days, and did not succeed in getting poured from one ton to thirty hundredweight at any one of the six heats. The foreman said they could not get enough wind. Just fancy! On the sixth day the superintendent asked me (I was a stranger at the time) what I supposed was the matter. I told him that he did not have fuel enough on his bed, and that he was blowing on iron instead of coke. He simply laughed at me and walked away, and at this time they would throw off the governor belt and let the engine blaze away as fast as it could run. Now, if we had owned a blast-meter at this time, it certainly would have shown a great pressure, but the wind was doing no good."

Mr. Grindrod thinks "it is a very good plan to make the first charge of iron light iron, if it can be done, as this puts no heavy strain on the bed, but keeps it in good condition for the heavier charges." He does not regard it as "good practice to melt any more iron on the bed than on the other charges," and makes it a point to melt light iron on the last charge, as it makes clean and quick melting. "Now, in regard to the iron to be charged, the scrap should be assorted, the heavy chunks placed in the middle of the cupola, and should never be put on before the third charge, and never on the last. It should lie with the foreman to say how many chunks he can carry successfully in a charge, and, by way of experiment, he must be sure he does not put on too many at first, but feel his way by starting with a little, and, if his cupola melts even, to increase them until he can tell just about what his cupola will melt successfully. Another important point is in having charges level. There should be in every charge enough small iron to fill up all holes, for close charging is economy in time and fuel; open charging is wasteful in fuel, and the melting is not even. If the above points are followed, I am satisfied no person need have any trouble about melting iron even, hot, quickly, and economically."

Differential Recorder for Gaging Flow of Water from Submerged Orifices.

ONE of the concomitants of water-power supply from large dams owned by companies, and from which many manufactories obtain their supply of power at rates proportioned to their consumption, is the measurement of flow, respectively, to the different consumers. Neither hydraulic engineers or owners of factories need to be reminded of the dissatisfactions liable to be experienced by both parties to such a transaction. The origin of some of these dissatisfactions lies in the nature of weir measurement, as pointed out in an article in *The Engineer* (London, Oct. 2). The article deals with a new instrument for measuring water-flow, invented by Dr. J. H. T. Tudsbery for a different purpose, but adapted to water gaging by Sir W. H. Bailey.

We herewith reproduce the illustrations and condense the description, not only on account of the ingenuity of the device, which renders it an interesting mechanical study, but also because its action and the principles involved are likely to interest all practising engineers. Without touching upon the liability to error in weir measurement, which the article reviewed points out, or the advantages of, and hitherto existing objections to, submerged orifices as compared with weirs for measuring flow of water, we simply remark that it is in connection with such orifices that Dr. Tudsbery's differential recorder is used. It is claimed that it removes the only serious practical objection to the otherwise desirable method of gaging by submerged orifices,—to wit, the hitherto existing necessity of making two observations to determine the head.

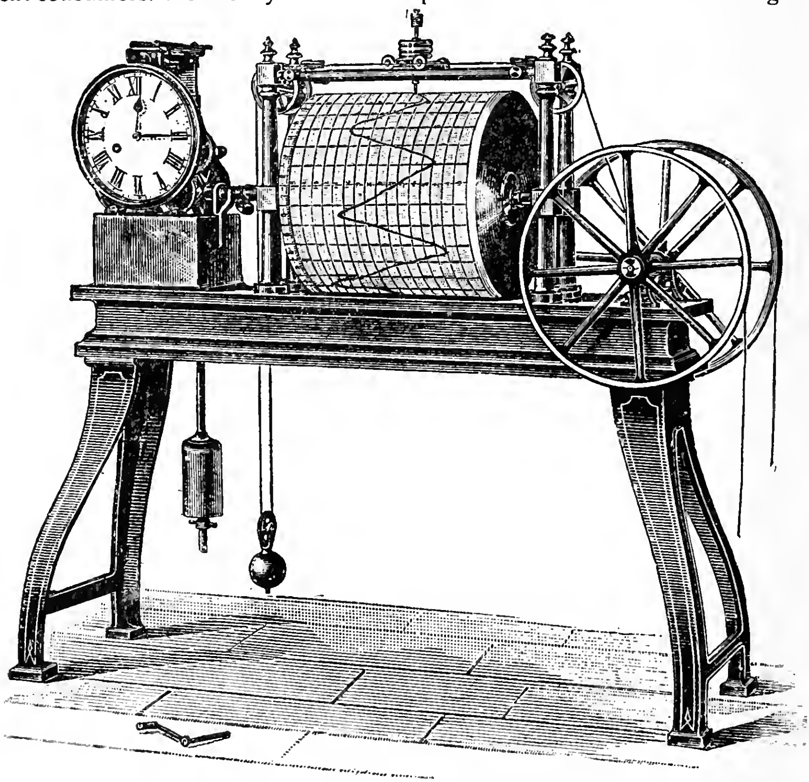


Fig. 1—TUDSBERY'S RECORDER

" Its essential feature is the ccn binaton by means of a suspended pulley, of the actual motions of two floats to reproduce their relative motion on any desired scale in a single pen or pencil of the kind with which recording gage apparatus is ordinarily equipped. It will be understood that by the use of two pencils, one fixed to each float, the head would be measurable by the difference in the space separating the two traces, but Dr. Tudsbery, by using one pencil on the right of a line coupling the two floats, gets a differential motion, and the head is measured by the space between the base line on the drum and the pencil trace. . . . This contrivance enables the head, or relative water levels, to be measured directly in a single operation, no matter how the absolute water-levels on either side of the orifice may vary.

"The determination of the coefficients of discharge proper to such vertical submerged orifices as are referred to has been within the last few years made the subject of careful inquiry by several investigators, among whom may be specially mentioned Mr. T. G. Ellis and Mr. Hamilton Smith. Reference to the work on 'Hydraulics' by the latter engineer will convince any person of the importance attaching to the question of gaging by means of orifices, and of the care that has been exercised to obtain trustworthy coefficients of discharge applicable to them. For the coefficients applicable to larger submerged orifices, such as are met with in river, canal, and dock works, the investigations of Mr. R. H. Rhind, published in the 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lxxxv., may be consulted with advantage whilst many valuable isolated data are found in the pages of occasional papers and essays treating of particular hydraulic works.

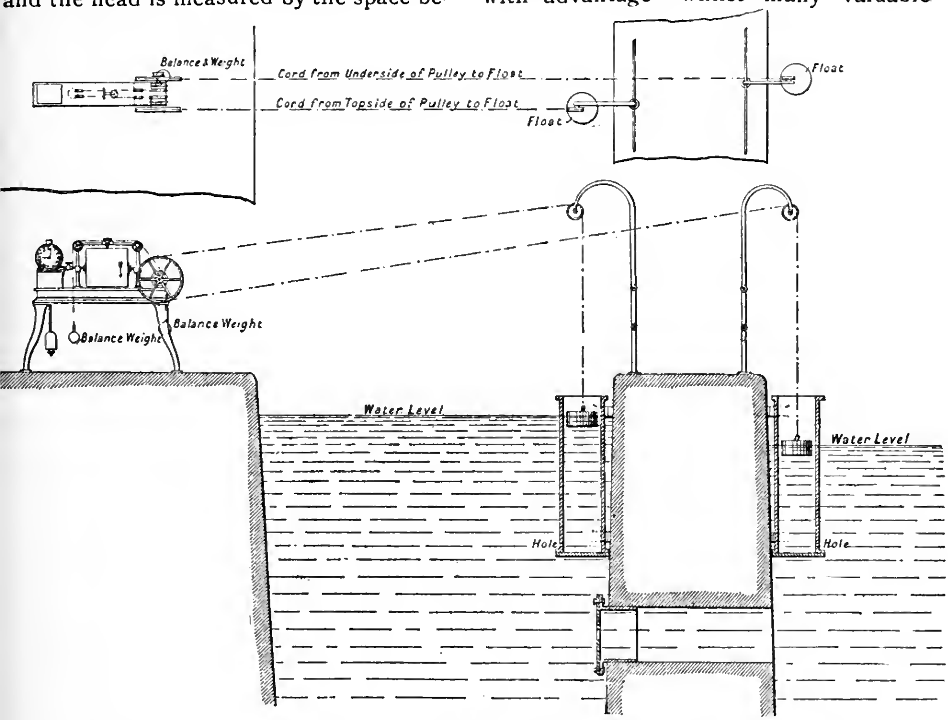


Fig. 2—DIAGRAM OF RECORDER

"The recorder may be described as consisting of a cast-iron lathe bed on legs. It is fitted with an eight-day pendulum clock beating seconds; the drum is 42 inches in circumference, revolving once in seven days, giving ¼ inch to the hour on the diagram, the drum being 14 inches long, recording a difference in level of 2 inches to the foot for a fluctuation of 6 feet. These measurements may be varied according to the delicacy of the diagram required."

It is said that one of these recorders has recently been placed at the mouth of the river Weaver to indicate and record the amount of water flowing through the Manchester ship canal, that they have been adopted by the Western Australian government for tide gages, and that the British fisheries commission is about to use them for investigating and indicating the fluctuation of rivers.

Interchangeable Machine Details.

In a discussion of the accuracy of work produced in the shops of H. Bollinckx, a famous Belgian steam-engine builder, the use made of emery grinding machines in securing accurate fitting of hardened surfaces is particularly mentioned by *The Engineer* (London). While it thus appears that the value of emery grinding as a shop method is recognized in Europe, it also appears from the same article that English shops are and have been slow in adopting it.

"H. Bollinckx . . . gets up his work in a way not as yet nearly as extensively adopted as it deserves to be in this country, mainly by the use of emery grinders. All the steel work, having been brought nearly to shape and size, is then hardened, and subsequently gone over with emery wheels fitted in special tools designed for the purpose. When the steel is carefully finished first, if it is subsequently hardened a certain amount of distortion is sure to take place, which is fatal to accuracy, and the result is that steel unhardened is only too often used. The emery grinder gets over this difficulty, and surfaces of extreme hardness can be adopted, and thus their durability is much augmented. The precision obtained is so great that the cranks are fixed on the shafts and levers on weigh-shafts without any keys, the parts being forced into their places. More noteworthy still, the fly-wheels are forced on their shafts, and have no keys.

"We believe that H. Bollinckx is the only engineer who has had the hardihood to pursue this system so thoroughly, and in all cases his practice has been successful.

"The Corliss valve rods and covers are got up so true that they are steam-tight, metal to metal, not the smallest atom of packing being used. The surfaces are simply greased and bolted together. All the workmanship is throughout of the finest possible kind, all dimensions being worked to with a minute accuracy so unusual in England that we can only name two firms which have adopted a system which has everything to commend it. The great obstacle, we have been told, to its adoption in this country is that it is very difficult to find Englishmen who will work to so high a standard of excellence,—a statement the general truth of which we venture to doubt."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

THE MACHINE SHOP.

8720. Blacksmithing Operations. B. F. Spalding (Working cold metal, drop forging, undercut dies, a mortised die, fatigue of metals, rate of stress and of recovery, proper heats, heavy drops). Am Mach—Oct. 15, 2500 w.

8721. Some Practical Examples of the Use of Compressed Air in Machine Shops, a Belt Shifter, Centre Grinder, Bolt Cutter (Illustrated descriptions of applications named in the title). Am Mach—Oct. 15. 800 w.

8795. The Lorain Foundry Company (Illustrated description of a completely up-to-date foundry, recently built and equipped, and considered to be a model establishment). Ir Age—Oct. 22. 1000 w.

8800. Molding Large Pulleys. L. C. Jewett (Illustrated description of a departure from ordinary methods). Am Mach—Oct. 22. 900 w.

*8855. Copy Work (A dissertation on standard guides for controlling cutters). Eng, Lond—Oct. 9. 2000 w.

*8887. Interchangeable Details of Machinery (The necessary appliances for the production of interchangeable details are herein ably discussed. Editorial). Mach, Lond—Oct. 15. 2200 w.

8924. Design of Stepped Cones (Klein's Diagram, which is convenient and sufficiently accurate, is illustrated and the method of using it explained). Am Mach—Oct. 29. 1800 w.

8991. System in the Drafting Room.

James C. Hemphill (Illustrated Description of a system in actual use for arranging, classifying and indexing miscellaneous drawings for easy reference). Mach—Nov. 700 w.

9046. Band Saws for Metal Work (Translated and condensed from "Zeitschrift des Vereines Deutscher Ingenieure," by Gus C. Henning. Illustrates and describes forms of band saws used in some of the most famous shops, and presents the features of current practice with these tools). Am Mach—Nov. 5. 3,800 w.

9047. The Bottom of a Foundry Cupola. L. C. Jewett (A leaf from the experience of a practical foundryman). Am Mach—Nov. 5. 1300 w.

9048. Inserted-Tooth Mills. Horace L. Arnold (Present practice in the use of these mills in some notable manufacturing establishments). Am Mach—Nov. 5. 1100 w.

9049. Circular Milling. C. O. Griffin (Illustrated description of a successful attachment to go on the horizontal spindle machine and to do face-plate work). Am Mach—Nov. 5. 1100 w.

9050. Handle-Bar Bending. Hugh Dolnar (Illustrated description of current methods). Am Mach—Nov. 5. 1000 w.

9052. Annealing. H. K. Landis (General remarks upon the importance of annealing in many operations. Its nature and effects). Ir Age—Nov. 5. 2000 w.

9109. Improvements in Cupola Practice (Answers of prominent foundrymen to a circular letter of inquiry as to the direction in which there is greatest room for improvement in foundry practice). Ir Tr Rev—Nov. 5. 1200 w.

STEAM ENGINEERING.

8713. The Ball Engines at the Apollo Iron and Steel Works (Illustrated detailed description of engines installed at the great rolling-mill of the Apollo Iron and Steel Co., at Vandergrift, Pa.). Ir Age—Oct. 15. 600 w.

*8751. The Compound Winding Engine at the Great Western Colliery Company's Pit, with Notes on Its Comparative Steam Economy. Hugh Bramwell (Illustrated description of the engines, with numerous indicator diagrams and tabulated data). Ind and Ir—Oct. 9. 1800 w.

8762. Problems in the Use of Liquid Fuel (General review of the present state of the art and of recent Government experiments with oil fuel and appliances for using it). Safety V—Oct. 1700 w.

*8782. A Recording Indicator. W. O. Amsler (Design of this instrument). Sib Jour of Eng—Oct. 2000 w.

8788. Testing Steam Plants (Editorial argument favoring the testing of steam in working condition when operated in the manner which the designer planned, and determining how much coal is required to do the work). Eng Rec—Oct. 17. 1300 w.

*8856. Combustion of Bituminous Coal in Boilers. (Difficulties in obtaining smokeless combustion referred to varying composition of coal which renders necessary a variable supply of air for combustion). Eng, Lond—Oct. 9. 600 w.

8923. A Triple-Expansion High-Speed Engine (Illustrated detailed description). Am Mach—Oct. 29. 1000 w.

8925. American Locomotive Pistons (From the report of a committee of the Amer. Ry. Mas. Mech.'s Assn. Illustrated description of various forms used in American locomotive practice). Am Mach—Oct. 29. 1800 w.

8947. Inverted Triple-Expansion Vertical Corliss Engine at the De Beers Mines, South Africa (Illustrated detailed description). Power—Nov. 1100 w.

8949. The Barnard Water-Cooling Apparatus (Illustrated detailed description). Power—Nov. 1000 w.

*8988. The Economic Combustion of Fuel. Frederick Grover (The volumes of air needed for economical combustion are indicated graphically, and losses of heat are indicated in the same way). Prac Eng—Oct. 23. 1800 w.

8992. Valve Gears. E. T. Adams (The author promises with much that is old to present something new in the treatment of the subject. The first part deals with the theoretical indicator card, and construction of the slide valve). Mach—Nov. Serial, 1st part. 2700 w.

*9005. Watson's Balanced Water Gauge (Illustrated description of an unbreakable water gauge for steam boilers). Eng, Lond—Oct. 23. 800 w.

*9064. Reading the Indicator Diagram. F. F. Hemenway (Explanation of the significance of peculiarities of indicator diagrams adapted to the comprehension of those who have not familiarized themselves with the use of the instrument). Loc Eng—Nov. 2000 w.

9071. Notes on Coal. Charles F. White (Read before the Western Soc. of Engs. Data and observations on the water measurement in coal tests, variations in repeated tests, and notes on the relations of high-grade and low-grade coals. With discussion). Sta Eng—Nov. 3500 w.

MISCELLANY.

*8661. The Relations of Invention and Design to Mechanical Progress. C. L. Redfield (A comparative analysis of discovery, invention, design and manual skill and of the methods of fostering them). Eng Mag—Nov. 2800 w.

8671. The Theory of Energy in Hydraulics. L. M. Hoskins (The author attempts to supplement what he thinks to be an inadequate treatment of this subject). Am Gas Lgt Jour—Oct. 12. 1200 w.

†8701. Boiler Bearings (Illustrated description of a roller bearing as applied to car axles). Ind & East Eng—Sept. 12. Serial. 1st part. 2800 w.

8715. The Bicycle Wheel. E. D. Sewell (The suspension wheel in the various forms it has assumed since first invented by Leonardo da Vinci in 1490. Illustrated description). Sci Am—Oct. 17. 1800 w.

8722. Reversing Motors, with Magnetic Brake. Willim Baxter, jr. (Illustrated description of an application of the magnetic brake to a series-wound motor, and also the manner in which it is connected with the circuit wires). Am Mach—Oct. 15. 1000 w.

*8769. Address of Sir Douglas Fox to the Mechanical Science Section of the British Association (General review of progress). Engng—Oct. 9. 7000 w.

8770. A Modern Motor (The advantages of gas engines in points of economy, efficiency, cleanliness and safety). Pro Age—Oct. 15. 1700 w.

8771. Gas Engines in the Casino of Royan (Illustrated description). Pro Age Oct. 15. 1400 w.

8772. Gas Engines for Isolated Electric Plants (Illustrated description of experiments with a 10 h. p. gas engine for isolated lighting at Racine, Wis.). Pro Age —Oct. 15. 700 w.

8773. Gas vs. Steam Engines for Hoisting (General review with numerous examples. Illustrated). Pro Age—Oct. 15. 1800 w.

8774. Gas Engines in the Belfast Electric Lighting Plant (Abstract from paper of Victor A. H. McCowen read before the Inst. of Mech. Engs. Illustrated description). Pro Age—Oct. 15. 1800 w.

8776. An Air Hoist for Mercantile Purposes (Illustrated detailed description). Com Air—Oct. 600 w.

8778. Air Volumes Used in Engines (Formulae and data). Com Air—Oct. 400 w.

8779. The Application of Compressed Air to Cranes and Hoists. William Prellwitz (Illustrated description of a 20-ton travelling crane driven by compressed air). Com Air—Oct. 1200 w.

8796. The Cheapening of Farm Machinery (The present state of the farming machine industry and the extent of its aid to agriculture). Ir Age—Oct. 22. 2200 w.

8797. Experiments with Glass Bearings. George D. Rice (Illustrated description of experiments with glass bearings, which shows that while not reliable in cases of emergency, they may yet find a place for special purposes). Ir Age—Oct. 22. 1000 w.

8799. The Cost of Air Compression. Frank Richards (How it should be reckoned for the most improved compressors). Am Mach—Oct. 22. 1000 w.

8801. Ball Step Bearing and Magnetic Brake of the Sprague-Pratt Electric Elevator. (Description). Am Mach—Oct. 22. 1200 w.

8920. Rope Transmission. J. F. De Voll (Read before Ass'n No. 2, of Missouri, N. A. S. E. An entirely practical dissertation upon rope driving). Age of St.—Oct. 24. 2000 w.

8921. The Decimal System of Gauging Adopted by the American Steel Manufacturers' Association (Report of committee favoring and recommending the adoption of a decimal gauge which will measure all materials in thousandths of an inch. The form of gauge is illustrated). Ir Age—Oct. 29. 3000 w.

8936. The Bates Thermic Engine Co. (Illustrated description of a gas engine invented by M. Gardie, of Nantes, and improved by Maurice Lorois, now being exploited by the company named. Also editorial remarks and criticisms). Eng News—Oct. 22. 4000 w.

8948. The Erection of a Large Steel Stack. Fred N. Dillon (Illustrated description of the raising of one of three steel stacks of large dimensions, each stack being raised integrally and placed on its base. The one illustrated has a height of 130 ft. and a diameter of 60 in.). Power—Nov. 1400 w.

8990. Steel Gearing. R. Grimshaw (Formulae for properly proportioning and general remarks). Mach—Nov. 1400 w.

*8997. Shock Prevention in Machinery. W. H. Atherton (The various methods of preventing shock formerly used and now in use are briefly set forth, with some general remarks on each method). Mech Wld—Oct. 23. 2200 w.

9051. The Sprague Worm-Geared Electric Elevators (Illustrated description of an example of the most modern approved practice in worm gearing). Am Mach—Nov. 5. 1100 w.

†9090. Pneumatic Power Applied to Workshops. John Davis Barnett (Records the present position of air power as part of a craft, illustrated more especially by railway shop work). Trans Can Soc of Civ Engs—June. 5800 w.

9102. A High-Duty Pump for Elevator Service in Buffalo, N. Y. (Illustrated detailed description, with data of duty tests and dimension table). Eng Rec—Nov. 7. 1800 w.

†9112. The Law Relating to Accidents in Factories (Deals principally with rubber factories, but is also applicable to any factory. A compilation from legal authorities). Ind Rub Wld—Nov. 10. 1200 w.

*9113. Self-Propelled Vehicles. Sir David Salomons (Abstract of the inaugural address to the Liverpool branch of the Self-Propelled Traffic Assn. General discussion of legal, technical and practical aspects of the subject). Ind & Ir—Oct. 30. Serial. 1st part. 4,300 w.

MINING & METALLURGY

A British View of the American Iron Trade.

It is always of interest and often of profit to realize the aspiration of the Scotch poet and "see oursels as ithers see us"; in pursuance of this desirable end, therefore, we present two views of the American iron-trade situation as estimated by British authorities.

The first is from *The Iron and Coal Trades Review*, and is an excerpt from an article entitled: "How to Recover Our Waning Trade." The paper is introduced by a strong and appreciative review of the energy, courage, and perseverance of the English trader, who is described as desiring simply "a fair field and no favor," trusting to his own powers to win the supremacy. But, viewing the existing conditions, the writer of the article does not find these primal requisites. "Free trade has not been adopted by the nations of the world, as it was expected by the Cobden school that it would be." "Great Britain stands isolated among the great industrial nations in her economic system," and herein this evidently strong protectionist writer finds her disadvantage.

In fact, he seems to see no remedy but the adoption of protection by Great Britain. Reciprocity is discussed and found wanting; the adoption of free trade, even by the United States, promises no relief. "No man who has carefully watched the recent course of industrial movements in the United States will readily admit that the adoption of free trade by that country would be likely to help England, except, at the most, in a very temporary and unstable fashion. So far as the iron and steel industries, and the collateral trades of machine-making, cutlery, and implement-construction, are concerned, we do not hesitate to say that it would not help us at all. This is a bold assertion, and twenty years ago it would have been deemed ridiculous. But many things have happened since then. In several of the principal iron-making States, the cost of producing pig-iron is considerably lower than it is in any part of Great Britain. Common labor to-day is being purchased at some of the large ironworks in Alabama and Tennessee for 17s. per shift, or less than it costs in any part of England under similar conditions. Alabama is now exporting pig-iron to Europe, and is likely to continue to do so in larger quantities. American coal is now shipped to continental ports, and shippers are looking forward to a much larger business of this kind in the time to come. American machine-tools are being more and more extensively used in Europe. American locomotives are preferred to English, and are admittedly cheaper in first cost, not only on the American continent, but in Japan, Russia, and even in some of our own Australian colonies. American armor-plates and American projectiles compete with our own in many countries, and American rail manufacturers are now wresting numerous orders from their English competitors in South and Central America, Japan, and other countries. But, most significant and ominous of all, American manufacturers have captured the largest half of the Canadian markets for iron and steel, although they are not in any way favored, and they even look forward to supplying Canada with tinplates, which they are not at all unlikely to do within the next few years. The United States have cheaper fuel, cheaper labor,—always relatively to its efficiency, and sometimes in reference to its nominal value,—cheaper ores, cheaper transport, and cheaper pig-iron, than we have in Great Britain. They are likely to continue to enjoy those advantages; they mean to maintain them, and to make good use of them in the time to come. Is it likely, therefore, that we should gain much, if anything, by reciprocity with such a country as the United States? Any advantage resulting from reciprocity would be a mere flash in the pan. In a few months, at the most, the American manufacturer would get abreast of us, and, in seeking to do this without protection, he would be the better fitting himself for that ultimate struggle between British and American industry which must henceforth be fought out without fear, favor, or affection in every neutral market throughout the wide world."

The second view is that of an editorial writer in *Industries and Iron*, who, after reviewing the condition of the American iron trade during 1895 and 1896, continues:

"Under these conditions (*i. e.*, overproduction at home) it is only natural that those producers who are within easy reach of shipping facilities should endeavor to open up a foreign trade for the purpose of relieving somewhat the heavy stocks which have accumulated. Quite a little 'storm in a teacup' was created when about April last two small cargoes of pig-iron were received in this country—at Middlesborough, if we remember rightly—from Birmingham, Alabama. The storm was, however, somewhat allayed when it was officially announced by the shippers of the iron—the Sloss Iron and Steel Company—that there is no significance to be attached to our shipment of pig-iron to England. . . It just so happened that, owing to light shipments of cotton, several vessels wanted stiffening, and we were enabled to get an abnormally low rate of freight, which allowed us to make the shipment."

"For a time nothing more was heard of American pig-iron in this country; but, in view of the downward tendency in prices and the steady increase in stocks, notwithstanding the decreased production, in America, other producers have been tempted to try their chance in the English market. The result is that the competition of American pig-iron is becoming more of a reality in districts where it can be delivered at a low cost of carriage, and considerable purchases have been made recently, chiefly forge qualities, for use in the finished-iron works in the Warrington and Wigan districts. Furthermore, the quality is reported to be satisfactory, and it is reported that one large firm of iron and steel merchants has recently imported about ten thousand tons of American pig-iron while from New York we learn that the Tennessee Iron and Steel Company has just received an order for three thousand tons of pig-iron for England.

"It is not only in pig-iron that we are experiencing an American invasion, as it is reported that American steel rails are being offered in this country at lower rates than those demanded by English producers, while Lancashire makers of steel billets are meeting with competition, American billets being offered at about £4 per ton, delivered Warrington. Although the existing low prices in America, and the fact that all branches of the iron and steel trades in this country are just now exceedingly well off for orders, may enable a fairly large trade to be temporarily done in imported material, yet we have no fear of it becoming of a permanent character."

Neither writer can well be suspected of any bias in favor of the American trade. Their coincident and rather unexpected views will furnish food for thought, though they may be distasteful to the political world who love to talk of the "pauper labor of Europe" and to represent our manufacturers as needing the field on their side and demanding a monopoly of the favors.

Calcined Lime in the Blast-Furnace.

THE possibility of an important improvement in blast furnace practice through the use of calcined lime in place of limestone, says Mr. O. W. Davis in the *American Manufacturer*, is a topic which is exciting a good deal of interest in England, but which has received very little notice on this side of the water; and even on the other side "the real issue has been somewhat obscured by a sharp controversy over the matter of chemical reactions in the blast-furnace."

"Out of the smoke of the contest, however, certain facts have developed"; the clearest conclusions, which are at the same time the most favorable to the practice are embodied in the report of Mr. Charles Cochrane, former president of the Mechanical Engineers, laid before that body in 1889, and "giving the results of the opera tion of two of his furnaces at the Ormsby Iron Works.

"These furnaces are 76 feet high, 20,000 cubic feet contents, and were run for several months alternately on raw and calcined limerock, from the latter of which about 85 per cent. of the carbonic acid of the rock had been driven off by previous calcination. The result shown was an actual saving in fuel of 18 per cent. and an increase of output of pig iron of over 14 per cent. from use of the calcined rock."

Sir Lowthian Bell disputed the accuracy of these figures on theoretical grounds; but he and others siding with him admitted "an undoubted economy in the use of caustic lime in furnaces fifty feet high and under, while denying such economy in larger stacks."

At the Belgian meeting of the Iron and Steel Institute in 1894 the question was revived, and Sir Lowthian Bell presented a paper designed to support his position. But his figures show that two of the Clarence furnaces, 80 feet high, had been run alternately for several months on raw and calcined lime, and that the average output of the furnaces was increased 10 per cent., and the fuel consumption per ton of iron decreased 8½ per cent., by use of the calcined lime. His analyses further showed that his "calcined" limerock still carried 32 to 35 per cent. of carbonic acid, only 7 per cent. having been driven off in the kilns. It appeared also that, for this exceedingly imperfect calcination, he had used about one ton of small coal to three tons of limerock at a cost of about 38 cents per ton of rock. It is not surprising therefore that Mr. Cochrane remarked: "If Mr. Bell employed such imperfectly calcined rock as to contain 31 to 35 per cent. of carbonic acid, out of a possible 42 per cent., it is no wonder that he condemned the practice."

This was about in line with the results reported by Mr. Windsor Richards, from Eston furnace experience, at the former meeting.

Mr. Chas. Wood, of Middlesborough, stated that for the past twenty-five years he had used calcined lime in his furnaces, and because he had found it had paid him to do so. He found that he "worked with less coke, got more pig iron, used less blast, and had richer gases for his stoves and boilers, than when using raw lime rock."

Mr. Davis thus sums up the conclusions.

"It appears then from the above:

"That all parties agree that in furnaces of 50 feet and under the use of calcined lime results in great economy of fuel and increase of production of iron.

"It was shown by Mr. Cochrane that in furnaces 76 feet high he secured a reduction of fuel of 18 per cent. and an increase of pig iron of over 14 per cent. by use of a limestone from which 85 per cent. of the contents of carbonic acid had been removed by previous calcination.

"Mr. Bell reports a saving of fuel of 8½ per cent. and an increased output of iron of 10 per cent. by use of a limerock from which only 7 per cent. of the carbonic acid had been extracted.

"Mr. Windsor Richards reports no saving of fuel, but an average increase of output per furnace of 11 per cent. in furnaces 80 feet high, but gives no statement as to the relative calcination of the rock.

"From the tenor of the entire discussion, it seems to be a fair inference that with a moderately well burned limerock, say, with 30 per cent. out of the 42 per cent. carbonic acid expelled, there will result a saving in fuel of not less than 12 per cent. and an increase in output of 12 per cent. or more, and consequently that the whole matter resolves itself into the cost of calcining the flux."

He rightly considers that the matter is of extreme importance to American furnace-men "in these days of low prices and small margins,' especially if (as suggested elsewhere in these columns) there is actually a prospect of finding an English market for our iron, and if further, as suggested by Mr. Davis, American practice seems particularly efficient in means for cheaply calcining the limestone.

That the use of calcined lime will facilitate furnace reactions, permit of heavier burdens, and increase the output of pig (while incidentally furnishing richer gases) seems evident enough. It may seem likely also to result in fuel economy in the furnace itself, but it is not clearly apparent why the total fuel-consumption (including that used in calcination) should show an economy.

Separate calcination seems to afford a double opportunity for loss of waste-heat and to make an individual fuel-consuming process of something which, one would think, would be accomplished naturally in the upper part of the stack.

But such speculation resembles the theoretical digression which is said to obscure the main issue on the other side. The practical results quoted certainly warrant thorough experiment in American furnaces, and actual trials will furnish the best basis for conclusions.

Mining Education in England.

THE subject of possible or evident defects in our systems of technical education has recently occupied considerable space in the journals, and has brought out rather a sharp discussion, in which severe things have been said concerning the course in mining engineering and the capability of the graduates turned out. We were doing the thing very badly, we were told, and a complete reorganization was necessary.

It may be interesting, and possibly comforting, to find that our English cousins, in the privacy of the home, say similarly hard things about their own institutions.

The following extracts are from an article on "English and Foreign Experts" in *The Mining Journal, Railway and Commercial Gazette* (London), and are offered without comment, and with the reminder that we often say things of ourselves which we would resent from others, or which, perhaps, others would not be disposed to say of us.

"No one who has followed the recent history of metalliferous mining can have failed to be struck by the very large extent to which foreign mining engineers have been given the leading position in the technical direction of mining ventures carried out by British capital. In this respect something like a revolution has taken place in the conduct of this branch of enterprise. A few years ago the financer in London who had taken up the exploitation of a mineral property would apply to an English firm of experts, and would secure the services of an accredited English engineer to report upon its prospects and value.

"Since the development of the South African gold fields, however, it must be admitted that the glory of the English mining expert has to a considerable degree departed. It is a confession which we make with considerable reluctance, but which, at the same time, in the interests of the mining profession, it seems desirable to make."

The complaint is said to be "that Englishmen did not adapt themselves to the strange conditions of working on the Witwatersrand. The college-taught expert was declared to be a compound of British pedantry and German scholasticism, with little or no practical experience and an unintelligent reliance upon inapplicable text-books.

"It is true that there were numerous exceptions to these strictures. Some of the most successful mines on the Rand have been developed by consulting engineers who came straight from the English technical institutions, or by managers who had learned everything they knew in Cornish tin times. At the same time it is impossible to shut one's eyes to the fact that there has been, as a whole, a tendency in South Africa to supplant Englishmen as engineers and managers by Americans and Germans. At the present time the most brilliant advisory positions in both the Transvaal and Rhodesia are held by men whose training-ground has been California, and managerships are increasingly coming into the hands of their countrymen. A young Englishman with the highest testimonials who goes out to Johannesburg will find considerable difficulty in obtaining a responsible position at a mine of which the directorate is almost entirely English, and the capital of which has been entirely obtained from England. In Western Australia the same tendency is exhibiting itself with even greater force.

"It is, however, probable—and we think,

most experienced English mining engineers will agree with the opinion—that the teaching in English technical institutions is a good deal more inelastic and unpractical than in the corresponding places of the United States and the continent. Students are grounded in all the details of geology and the metallurgy of the laboratory, while they are taught scarcely anything of the actual working methods of existing mining fields; and too many of them quit their college quite convinced that they are able to take up the management of any mine in the world. If there were more appreciation of the absolute necessity of studying mining itself before essaying to direct all its complicated processes, we feel confident that the present prejudice against British mining engineers would not exist amongst mining financiers.

"One very simple reform which would have a very useful effect in training our young mining engineers would be to infuse a more practical character into the papers read before our technical societies. Much has been done of late years in this direction, but a great deal more can be accomplished. Even as they are, however, English mining engineers should certainly be preferred by English shareholders to the foreign experts who threaten at present to monopolize the direction of mining. The French have set us an excellent example in this respect. In the mining companies in which their holdings are predominant they have insisted that places should be found for Frenchmen of sufficient knowledge and ability. Without sacrificing the prosperity of a company to patriotism, English shareholders might very well assume the same attitude."

If the criticisms on the educational system and its results are valid, the concluding suggestion is hardly likely to find favor with financiers or shareholders, or to result in satisfaction to anyone, if put into practice. The remedy, if one be needed, must be supplied by better engineering, not stronger patriotism. Sentiment is not an element of success in business; skill is.

Hydraulic Power for Mine-Pumping.

THE rising interest in the subject of power transmission in mines has prompted the appearance, elsewhere in the pages of this number, of a critical review of an important series of papers on this topic recently published. In general, electricity and compressed air have been regarded as the alternative agencies, with little attention to any other medium.

The *Colliery Guardian*, however, in a translation of a communication to the Société de l'Industrie Minérale (made by MM. Griot and Rodde, engineers at the Montrambert Colliery), suggest hydraulic transmission for mine-pumping. If successful for that purpose, as it is said to be it might find a wider application.

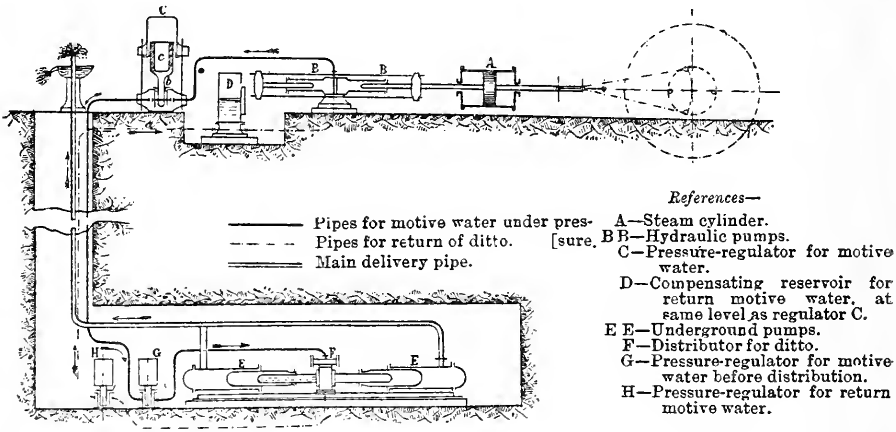
The Kaselowsky pumping engine, as it is termed, is in use at several German mines. "The principle of this system is to use water under great pressure—200 to 250 kilograms per square centimeter (mean, 3,200 pounds per square inch)—as the motive agent for the underground pumps that force the mine water to the surface in a single lift. This water under pressure is forced by pumps on the surface into the pumps underground, and again returns to the former, by steel pipes of very small diameter—60 to 70 millimeters (mean, $2\frac{9}{16}$ in.)—and, when necessary, a pipe of 10 millimeters ($\frac{13}{32}$ inches) inside diameter leads compressed air into regulating apparatus mounted on the water pipes near the pumps, for preventing ram-strokes. The water raised, which is only subjected to the pressure due to the height of the shaft, is forced to the surface in cast-iron pipes in a single lift.

"This method of pumping, therefore, only occupies in a shaft the space required by the two small pipes, forward and return, of the motive water, the delivery-pipe for the water raised, and the small pipe for compressed air, thus leaving the shaft, though used for pumping, almost completely free for winding. The plant comprises the pumps working on the surface and those underground, a diagram of which, showing the principle of the arrangement, is given by the accompanying figure, in which A represents the steam cylinder, B B the hydraulic pumps, C the pressure-regulator of the motive water, D a reservoir for making good any leakage of the motive water, E E the underground pumps, F their distributing valve, G the pressure-regulator of the motive water underground before being admitted to the pump barrels, and H the pressure-regulator of this water after exerting its effect in the barrels. The thick single lines in the diagram represent the forward pipes for the water under pressure; the dotted lines, the return pipes for the same; and the double lines, the delivery pipe of the mine water pumped up.

"The plant on the surface consists of a steam cylinder working hydraulic pumps for subjecting the water to the high pressure above mentioned. On leaving the pumps, this water passes into the pressure-regulator, C, which is very sensitive, for preventing ram strokes in the pipe leading the motive water to the bottom of the shaft. This regulator consists of a cylinder, *a*, in which works a plunger, *b*, for determining an increase or diminution of volume, being subjected to a constant pressure of compressed air at a lower pressure, and acting on another piston, *c*, of larger sectional area.

"The underground plant consists of a group of four single-acting pumps drawing the water of the mine and forcing it to the surface; and these four pumps are worked by the motor pistons acted upon by the water from the surface under a pressure of 200 to 250 kilograms per square centimeter (mean, 3,200 pounds per square inch). After this water has transmitted its power, it is raised to the surface, where it is again put under pressure by the hydraulic pumps. As, however, the underground pumps do not work at a uniform speed, there would be accelerations and retardations of speed in the pipes, which should be neutralized for preventing shock; and to this end a pressure-regulator, similar to that on the surface, but of smaller size, is intercalated in the pipes at the entrance to and exit from the valve chests, and supplied with air by a pipe of only 10 millimeters ($\frac{13}{32}$ inch) diameter.

"The underground and surface plants are, therefore, simply connected by a pipe leading down the motive water and another



bringing it back, besides the small air-pipe, so that the space taken up in the shaft is limited to these three pipes and the main delivery pipe."

The return of the motive water is considered of importance, both because it saves the lubricant with which the water is impregnated, and because mine-waters are often acid or muddy, and likely to cause incrustation or corrosion. Glycerine is used to prevent the water from freezing in cold weather: the pumps are said to work drowned without difficulty, and the loss in transmission to be reducible to "a few units."

Early Experiences with Fire-Damp.

UNDER the title, "Annals of Coal Mining and the Coal Trade," the *Colliery*

Guardian has been publishing a very interesting and often amusing historical review of the working of British collieries. With the deeper working of the seams began the trouble. The damp was first heard of in 1640, in the Mostyn colliery.

"After they had gone a considerable distance underground, and were in want of fresh air, the fire-damp gradually began to 'breed.' At first the workmen made but a sport of it, toying with it with their lighted candles, till one morning 'the first collier that went down, going forward in the witchet with his candle in his hand, the damp presently darted out so violently at his candle that it struck the man clean down, singed all his hair and clothes, and disabled him from working thereafter.'"

"In consequence of some warnings of this sort, the colliers selected one of their number more resolute than the rest—a man of purpose—to go down into the mine some time before them every morning to fire, or explode, the small accumulations of the gas. Clothing himself with the worst rags he had, saturated with water, this individual — subsequently known as the 'fireman' — advanced towards the places where fire-damp was supposed to exist, and, crawling forward, held a long pole before him with one or more lighted candles at its end. This ignited the fire-damp, if present, and produced an explosion of more or less violence, according to the quantity of gas accumulated. As the flame ran along the roof, the fireman lay flat on the floor of the mine till it passed over him. When his operations had been completed, the rest of the colliers entered the pit, and the motion of the air caused by their working prevented the gas from collecting during the day.

"This is the earliest account we have of this primitive method of dealing with fire-damp, which may be termed the firing system, and which was subsequently practised in many of the coal-fields when difficulties with the gas had become more general. It is spoken of as 'the ordinary way' by Professor Sinclair in 1672 (*Hydrostatics*, p. 294), and we have records of its being pursued at a later date in Shropshire, Staffordshire, Leicestershire, Lancashire, and Cumberland."

And in 1675, in these same workings at Mostyn, occurred a terrible explosion, by which the body of one of the victims, blown up the pit, was carried thirty-five yards into the air above its mouth.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

METALLURGY.

8688. Formulas for Determining the Value of Iron Ores. G. Teichgraber (Translated from "Stahl und Eisen." The formulas for the different elements affecting the cost of pig iron are worked out). Eng & Min Jour—Oct. 10. 900 w.

8691. Shall We Use Calcined Lime in the Blast Furnace? O. W. Davis (Facts developed from the discussion of this subject in England). Am Mfr & Ir Wld—Oct. 9. 1500 w.

8692. Blast Furnace Scaffolds. E. Bernard (Communication made to the Engng Assn of the Liege School, translated by H. H. Stoek. The writer thinks it possible to explain scaffolding simply by the method of fusion of blast furnace slags). Am Mfr & Ir Wld—Oct. 9. 1400 w.

*8695. Metallurgy of Gold. H. Van F. Furman (Its occurrence, its properties and metallurgical processes for extracting it from ores. Crushing and pulverizing machinery; amalgamation methods; concentration; chlorination and bromination; the cyanide process, smelting process, new methods; melting, assaying and parting gold bullion). Col Eng—Oct. 6000 w.

8736. Standard Specifications for Structural Steel (The text of the specifications adopted by the American Steel Mfrs). Ry Rev—Oct. 10. 1800 w.

8737. A Cheap Cyanide Plant. M. A. Knapp (Description of a small and successful plant constructed at Hawthorne, Nevada). Min and Sci Pr—Oct 10. 1100 w.

*8750. The New Basic Steel Manufacturing Process (Description, with editorial comment, of the patent of B. P. Stockman, by the use of which it is claimed that Cleveland or other iron not now available for steel making may at small expense be converted into steel which shows excellent analysis and answers to required tests). Ir & Coal Trds Rev—Oct. 9. 2200 w.

*8783. Steel. Robert Carr Lanphier (The essential features of steel, methods of producing it, its properties, &c.) Yale Sci M—Oct. 2500 w.

8794. Recent Developments and Standards in Armor and Heavy Ordinance. W. H. Jacques (Read before section G of the British Assn., Liverpool. A review of the progress made, with examination of tests made in various countries. The record is most satisfactory). Ir Age—Oct. 22. 2000 w.

8881. A New Gold Saving Process. Dr. P. Langhammer (Describes the process; the main point is that the gold does not and must not come in contact with water until it reaches the chemical solution). Min and Sci Pr—Oct. 17. 1500 w.

8882. A Hot Blast System for Copper Matting and Silver-Lead Furnaces (From advance sheets of a treatise on this subject by J. W. Nesmith. Illustrated description). Min and Sci Pr—Oct. 17. 3000 w.

*8904. The MacArthur-Yates Process of Gold Extraction, Dry Crushing, with Direct Amalgamation and Cyanidation. John Yates (From a paper read before the Federated Inst. of Min. Engs. Describes process, which is, in the main, the ordinary cyanide percolation process, the distinguishing feature being that the ore is subjected to a short preliminary agitation with the view of securing the amalgamation of as much of the gold as possible, and then raising the extraction). Min Jour—Oct. 17. 900 w.

*8905. The Electrolytic Desilverization of Argentiferous Lead by the Tommasi Process. Dr. D. Tommasi (The principle upon which this process is based is stated, apparatus used is described, also advantages and working cost). Min Jour —Oct. 17. 1600 w.

8910. American Blast Furnace Practice (A reply to the statement made by John L. Stevenson, in "The Engineer," London, that the methods used in this country have not been very successful when adopted in England. Followed by illustrated description of furnace which has given excellent results). Am Mfr & Ir Wld—Oct. 23. 900 w.

8911. The Cyanide Process in the United States (Editorial review of the progress and succcess of this process). Eng & Min Jour—Oct. 24. 1500 w.

8913. On the Chemistry of the Cyanide Copper Assay. J. J. Beringer and H. W. Hutchin (A discussion of the conditions which affect the results in this process). Eng and Min Jour—Oct. 24. 1000 w.

*8952. Best Yorkshire Iron, and How It Is Made. E. Windsor Richards (An address at the opening of the metallurgical department of the Glasgow and West of Scotland Technical College. History of Lowmoor Iron Works, with a description of the methods adopted there). Eng, Lond—Oct. 16. 4700 w.

9030. Dr. Emmons's Transmutation of Silver into Gold (Letter from Stephen H. Emmens in reply to statements made by Prof. E. M. Endlich). Eng and Min Jour—Oct. 31. 1000 w.

†9044. On the Diffusion of Sulphides Through Steel. E. D. Campbell (Describes experiments selected from 40 diffusion tests, giving possible explanation of observed phenomena). Am Chem Jour —Nov. 4000 w.

†9045. On the Influence of Heat Treatment and Carbon upon the Solubility of Phosphorous in Steels. E. D. Campbell and S. C. Babcock (Researches undertaken with a view to determine whether chemical evidence could be obtained to prove that phosphorous may exist in steel in two forms). Am Chem Jour.—Nov. 1100 w.

9083. Alloys and Amalgamation of Gold. H. Van F. Furman, in the "Metal Miner." (A summary of the effect of small amounts of impurities on gold bullion). Min & Sci Pr—Oct. 31. 900 w.

†9118. The Direct Method Considered as the Future Metallurgical Treatment of Copper Ores, Argentiferous or Otherwise. Christopher James. (Full paper as read before the Inst. of Min. & Met., London. A complete account of the new process, with a condensed view of the old Welsh method of copper smelting, together with the variations which Continental practice and American practice have superimposed upon the old method). Inst of Min & Met, London—Oct. 19000 w.

*9123. Chemical Changes Involved in the Extraction of Metals from Their Compounds. J. M. Thomson (Extract from a paper read before the Soc. of Arts. An examination of the chemical changes taking place in the various processes). Col Guard—Oct. 30. 1500 w.

MINING.

*8697. The Cripple Creek Region. Arthur Lakes (Epitome of the United States Geological Survey's report on the Cripple Creek mining region, simplified and prepared for mining men). Col Eng—Oct. 5000 w.

*8698. Lead and Zinc. A. G. Leonard (A description of the mines of Iowa in the upper Mississippi region, with illustrations. The mode of occurrence of the ores, the minerals associated with them and the theories in regard to their deposition, with a description of some of the mines). Col Eng—Oct. 2300 w.

*8699. The Mining and Treatment of Coal (The first part treats of the washing of coal.) Ir and Coal Tds Rev—Oct. 2. Serial. 1st part. 1200 w.

*8700. The Geology of Africa in Relation to Its Mineral Wealth. Walcot Gibson (Abstract from a paper read before the Federated Inst. of Min. Engs. Brief sketch of African geology). Min Jour—Oct. 3. 2800 w.

*8714. Coal Pit Sinking in South Wales (Extract from address of Henry W. Martin before the South Wales Inst. of Engs. Describes method of rapid sinking, with illustrations). Ir and St Trds Jour—Oct. 3. 2000 w.

*8747. Gold in Chile. B. Becker (Part first briefly reviews its value as a producer in former centuries, and describes the country geographically, geologically and commercially). Min Jour—Oct. 10. Serial. 1st part. 1100 w.

8748. New Zealand Prospects (Editorial reviewing the bright prospects of this colony). Min Jour—Oct. 10. 1400 w.

*8760. The Sterlingshire Coalfield (Part first is a description of Bannockburn Colliery, which is laid out on the most approved principles for the saving of labor, separation and easy handling of coal, and dressing it for the markets). Col Guard—Oct. 9. 2800 w.

*8892. Improvements in Prussian Mining Methods (Experimental trials in wedging are explained and illustrated, with improvements in other methods of mining work). Col Guard—Oct. 16. Serial. 1st part. 2500 w.

*8896. Wallsend Coal (Account of work being resumed in collieries that have not yielded for nearly fifty years. Work was stopped, as the pumping appliances of that day were not adequate. Improved machinery has made working again possible). Col Guard—Oct. 6. 700 w.

*8897. Installation of a New Metal Guiding Apparatus (Briart System) Marc Warolus (translated from Revue Universelle des Mines, &c. Description of apparatus which was installed in No. 4 pit of the Monceau Fontaine and Martinet collieries). Col Guard—Oct. 16. Serial. 1st part. 2300 w.

*8898. The Grand Lake Coal Field of New Brunswick. R. G. E. Leckie (Its location and distribution, quality and quantity). Col Guard—Oct. 16. 1500 w.

*8899. Anthracite Coal Breaking and Sizing Plant, at Glyncastle Colliery. W. D. Wight (Read at the meeting of the Federated Soc. of Min. Engs. at Cardiff. Illustrated description). Ind & Ir—Oct. 16. 2200 w.

8918. Minerals of Cascade County. O. C. Mortson (The deposits in this part of Montana are essentially economic, such as coal, iron, fire clay, building materials, &c. The precious metals have not yet been found). W Min Wld—Oct. 24. 2200 w.

*8919. A New Mode of Sinking Shafts. From the "Federated Institute" (Describes the freezing process of shaft sinking; the advantage of the direct freezing method). Aust Min Stand—Sept. 17. 2300 w.

8975. The Development of Colorado's Mining Industry. T. A. Rickard (Review of its history from 1849 to the present). Min & Sci Pr—Oct. 24. 2800 w.

9082. Copper Deposits in Sonora, Mexico. I B. Storch (Information relating to the large deposit of copper ore in the mountain range Sierra de Canoneas). Min & Sci Pr—Oct. 31. 800 w.

9106. Future Gold Fields—Guiana. Charles E. Clarke (Considers the territory lying east of the Schomburgk line to be one of the great auriferous fields of the future). Eng and Min Jour—Nov. 7. 2500 w.

*9114. Chilian Nitrate of Soda Deposits (Gives an historical account of the discovery, how long known, the methods of mining, value, &c.). Engng—Oct. 30. Serial. 1st part. 2500 w.

*9121. The Use of Compressed Air in Canadian Mines (R. H. Brown and Charles Fergie contribute brief papers on this subject to the Canadian Mining Inst. Describing pumping by compressed air in Nova Scotia mines). Col Guard—Oct. 30. 2200 w.

*9126. Standing Tree-Trunks in a Liege Colliery. G. Schmitz in a communication to the Academie Royale de Belgique. (Facts which the writer thinks call for a fresh examination of opinions hitherto advanced regarding the formation of coal from vegetation in the very spot where the trees grew). Col Guard—Oct. 30. 900 w.

*9127. The Transvaal Coal Field. W. Forster Brown (Read before the South Wales Inst. of Engs. Review of the physical and geological features, quality, system of working, markets, &c). Col Guard—Oct. 30. 3000 w.

*9140. The Mineral Resources of Arizona. Thomas Tonge (Shows Arizona to be rich in minerals and reviews the development in the different countries). Min Jour—Oct. 31. 2000 w.

MISCELLANY.

*8690. Calculating Guibal Fans with Single Inlet. Emile Gosseries (Experiments made with the Guibal fan lately put up at the Sacre-Madame Colliery, Charleroi). Col Guard—Oct. 2. 2400 w.

*8696. Calculating the Friction of Haulage Ropes. C. F. Scott (From an article in the Journal of the Society of British Mining Students. Mathematical). Col Eng—Oct. 1000 w.

*8711. A new and Important Source of Phosphate Rock in Tennessee. James M. Safford (Describes the rock, which is Trenton, and is the result of long-continued leaching of the rocks by atmospheric and aqueous agencies). Am Geol —Oct. 1000 w.

*8740. Central Maryland Granites. Charles Rollin Keyes (Condensed from the fifteenth annual report U. S. Geological Survey. Some of the problems encountered in the study of these rocks, their classification, types and components.

Illustrated). Stone—Oct. Serial, 1st part. 2400 w.

*8741. On the Influence of the Diameter of Holes in Blasting Operations. James Ashworth (From "Colliery Guardian" experiments proving that a great difference in results is obtained by the mode of application, and that correct understanding of the subject is necessary to safety). Stone—Oct. 1100 w.

*8757. The Testing of Coals. Arthur Winslow (A plan to conduct a study of North American coals to furnish information of uniform reliability is outlined). Jour Assn of Eng Soc—Sept. 2400 w.

*8759. Mine Pumping with Hydraulic Transmission of Power. M. Griot and M. Rodde. (From a communication to the Societe de l'Industrie Minerale, Saint-Etienne. Description of Kaselowsky pumping engine, its principle, method of pumping, plant on the surface and under ground, with examples of working in different plants. Col. Guard—Oct. 9. 2800 w.

*8761. The Production, Value and Distribution of Coal in 1895. (Statistics from the report relating to the mineral industry of the United Kingdom). Col. Guard—Oct. 9. 1500 w.

8876. Iron in New South Wales. (Some facts and figures regarding the iron deposits and iron works in country named). Eng News—Oct. 15. 1000 w.

*8893. Interesting Boring Operations at Ilkeston. (A brief account of boring for a supply of water for the borough). Col Guard—Oct. 16. 900 w.

*8894. Iron Ore Mining and Pig Iron Production. (From the "Mineral Statistics of the United Kingdom" for 1895. A general summary of the production during 1895 and the quantity and value of pig iron). Col Guard—Oct. 16. 1400 w.

*8895. Co-Ownership of Coal Mines (Leading aspects and essential points of the question). Col Guard—Oct. 16. 2400 w.

8901. Story of Death Valley. (Review of a book by William Lewis Manly, "Death Valley in '49." The writer was one of the party who made the eventful journey). Min Ind & Rev—Oct. 22. 3000 w.

*8932. The American Iron Industry (Extracts from an article written by James M. Swank, and published in the Annual Report of the Association for 1895. Reviews the progress of the iron and steel industries from the middle of the 17th century, calling attention to the effect of the protective policy upon iron making in this country since 1860). Gunton's Mag—Nov. 2400 w.

†8963. The Production of Iron Ores in 1895. John Birkinbine (A summary of the production in the United States from 1889 to 1895 is given, the quantities of different classes of iron ore produced, production by States, and other important information). 5000 w.

*9002. Coal Cleaning Machinery at Aberamman Colliery (Illustrated description). Eng. Lond—Oct. 23. Serial, 1st part. 900 w.

*9016. Some Pressure Effects Shown by Colliery Explosions. James Ashworth (Comment on Dr. Haldane's paper, with especial reference to his statement that the pressure exerted by a colliery explosion is not excessive). Col Guard—Oct. 23. 2200 w.

*9018. The Electric Ignition of Blasting Explosives (Article from a recent issue of "Arms and Explosives," special reference being made to the part played by Mr. Frank Brain, of the Electric Blasting Apparatus Company, Cinderford, in the introduction of electric blasting to mining operations). Col Guard—Oct. 23. 2200 w.

*9021. The Use of Compressed Air in Mining and Metallurgical Operations (A brief estimate of the position of compressed air at the present time. Illustrated). Ir and Coal Trds Rev—Oct. 23. 1000 w.

9053. The Racing River Gold Region (Describes its location, discovery and value, giving information regarding its prospects). Ir Age—Nov. 5. 1600 w.

9081. Needed Mining Laws (Proposed mining laws for remedying the defects that exist in California, with editorial comment). Min and Sci Pr—Oct. 31. 6500 w.

*9088. The Valuation of Prospects. Howard West (Responsibility of prospectors, and points of interest).Can Min Rev —Oct. 2500 w.

*9089. Canada as a Field for Mining Investment. Dr. G. M. Dawson (From the "National Review." The mineral resources of the country and their prospective values). Can Min Rev—Oct. 4500 w.

9107. The Coke Works and Briquetting of Mineral Coal in Austria. R. Helmhacker (Some particulars of a successful industry). Eng and Min Jour—Nov. 7. 900 w.

9108. Production of Pig Iron in France and in the World. H K. Landis (Statistics from an article by M. Pourcel with notes. Tables and diagram). Ir Tr Rev —Nov. 5. 350 w.

*9122. The Analysis of Coke. George C. Davis (Describes methods for determining the percentage of sulphur and the amount and composition of the ash). Col Guard—Oct. 30. 1200 w.

*9124. Recent Explorations for Coal in Siberia. Gen. Venukoff (Translated from "L'Echo des Mines." An account of the principal groups of coal mines already discovered in those districts of Siberia through which the railway runs). Col Guard—Oct. 30. 1300 w.

*9125. The Production of Pig Iron. From the London "Times" (The improvement in this industry in Great Britain, calling attention to prominent features of progress). Col Guard—Oct. 30. 1800 w.

The Future of Calcium Carbid and Acetylene.

TAKING the ultimate price of calcium carbid at about $50 per ton, which, in his Cantor lectures on applied chemistry before the Society of Arts, he deems probable, Mr. James Swinburne thinks he can perceive a possible and even probable commercial future for the industry.

For the enrichment of gas he evidently thinks its use as yet improbable, because this use cannot be demonstrated to be profitable at any price at which the carbid seems likely soon to be supplied. The competition of acetylene with gas for general illuminating purposes he regards as at present highly improbable, especially since the illuminating power of gas has been so materially increased by the Welsbach mantle.

The distribution of acetylene to houses is one of the serious problems connected with its future. The delivery of the carbid to houses to provide consumers with the material for generating their own acetylene (all that is needed being the addition of water), says Mr. Swinburne, "sounds very simple"; but, as pertinent to this proposition, the early history of illuminating gas and of electric lighting is cited. A touch of humor seasons the good sense of the lecturer's remarks on this point.

"In the beginning of the century, coal gas was to be made on the spot in the same sort of way. All you did was to put coal into a retort, and heat it, and off came the gas. Yet this was never practised, except in special cases; and gas never came into use generally, until it was distributed by pipes ready for consumption. There are, of course, a few country houses and isolated establishments where they make a fluid they call illuminating gas. Exactly the same thing happened with the electric light. Each house was to have a gas-engine and a dynamo, and generate its own power. Then the next idea was that the accumulators were to be left at the houses with the milk, and changed next day, week, or month. But this never came into practice.

"These two schemes correspond very fairly with those of distributing carbid for use in generators, and distributing liquid acetylene in bottles. The generators would always be troublesome in an ordinary house. No doubt the light would be much cheaper and better than that of gas, as commonly used; but that is by no means everything. People forget that the average households are controlled by women. Women may understand people, but they are completely wanting in the faculty of understanding things; and they have the unreasoning conservatism and conventionality belonging to the undeveloped mind as seen in boys and savages. A woman hates everything new, and would never understand how to work an acetylene generator until it had been in use for generations, and it was considered part of the duty of a good housekeeper to make good acetylene, as it used to be to make good beer. Of course, even then it would be done by rule-of-thumb. There is more than this. The first thing a woman asks, when she sees anything new, be it a mouse-trap or a telephone, is: 'Will it explode?' Now, no one can say on his honor that an acetylene generator will not explode. He does not thing it will—in fact, he feels sure it will not, and he sincerely hopes it will not; but an explosion might possibly occur. This settles the matter. The only thing to be done would be to utilize a woman's instinctive hero-worship and belief in authority, and to arrange that acetylene generators should be recommended by her clergyman or her doctor. I say *her* doctor advisedly, as she does not believe in other women's doctors.

"The plan of distributing liquid acetylene in iron bottles sounds more promising, as very little goes a long way, and the bottles could be connected to the house-service by the acetylene company without the women of the house having anything to do with the matter."

As acetylene has not to compete with ordinary illuminating gas alone, but must also reckon with the Welsbach incandescent mantle, and as the latter requires no attention till it requires replacing, after a considerable period, acetylene, though it is a much more powerful illuminant, is handicapped beyond hope,—at least, for the near future.

Notwithstanding these facts, a large opening for acetylene is indicated apart from competition with coal gas. Mr. Swinburne thinks that "for country houses, carriages, omnibuses, railway trains, and on shipboard, it ought to have its own way." A good portable lamp for its use is a yet unrealized desideratum. Distribution in bottles is regarded as the safest and most convenient method.

"Too much has been generally said about the poisonous nature of acetylene. Experiments show that it is not at all a serious poison; and its smell is a great safeguard. It uses so little air in burning that, on the whole, it would be a very much more healthy illuminant than gas, oil, or candles, especially if it contains no sulphur. Healthy breathing is not generally sufficiently appreciated yet. Many people still sit in close rooms, and sleep with their windows shut; and the smaller air-consumption of acetylene would not really appeal to them very much."

Incandescent Gas Lighting in Paris.

THE city of Leicester, in England, is studying the improvement of street-lighting. Supplied with both gas and electricity, it has been a moot question which could be used to the best advantage in effecting the improvement desired. In order to form a better judgment, a deputation of the lighting committee of Leicester, accompanied by the corporation engineer, visited Paris to observe what is the state of the art in the French capital.

The Gas World (Oct. 10) publishes an interview with Mr. Colson, the engineer referred to, in which the results of the observations of the committee are stated and summarized.

Until recently "many of the main thoroughfares of Paris were lighted by electric arc lamps, but about two years ago the municipality, with a view to obtaining as much light at less cost, resolved on an experiment with 1,442 incandescent gas-burners. These were distributed mainly in the Place de la Concorde, the Champs Elysées, and the Place du Palais Royal. In the Place de la Concorde and along the Champs Elysées the lamp columns are placed at distances varying from about 15 to 25 yards apart, and they carry mainly single lanterns, in each of which are fixed two burners, each consuming 3½ cubic feet of gas per hour, or 7 cubic feet the pair. In the Place du Palais Royal the lamps, with a single burner in each, are clustered four or five on each post. At 15 candles per foot (the illuminating power generally obtained from this description of burner) the amount of light from each lantern is a little over 100 candles; but a higher efficiency than this is claimed by the use of the chimney employed, consisting either of ribbed glass or glass staves. The burners are not provided with a by-pass, the lighting being effected by a torch applied to the mouth of a tube projecting through the top of the lantern, which, being practically a continuation of the chimney, allows gas to pass to the end of the tube, upon opening the gas tap, and so affords means for lighting the burner. To prevent the mantle being damaged by vibration the burners are fixed on steel springs, while the strong draughts in the lantern are overcome by means of baffles. Of the general effect of the light given by the Auer-Bec system here described Mr. Colson speaks in terms of high praise. He found that at any point between the lamps ordinary print could be read with the greatest ease. Very marked, too, was the absence of the somewhat ghastly hue so frequently associated with the Welsbach light as seen in England, the improvement in this respect being obtained by the chimney that is used. Only one place in Paris was seen lighted with incandescent electric lamps, —*viz.*, the small square within the Palais Royal,—and there the light, while costly, was anything but effective. There are only some three or four prominent places in the center of the city now lit by arc lamps. The Place de l'Opéra and the gardens of the Tuileries are so lighted, but the contrast observable as you walk from one of these places into, say, the Place de la Concorde is not strikingly in favor of street-lighting by gas. Mr. Colson thinks that gas engineers and lighting committees who have the question of street-lighting under consideration would do well to see lights in Paris," from which we infer that Paris is now setting the pace for street lighting,

In connection with the above summary, some remarks by M. Henri Marechal, gas engineer of the Paris municipality, and author of a work, "The Lighting of Paris," are quoted from an article contributed by him to *Le Génie Civil.*

M. Marechal therein says that "the Auer-Bec of 115 liters, when applied to public lighting, gives three times as much light as the butterfly burner of 140 liters. At what cost is this increased lighting-power obtained? The duration of the mantles is a most important point, as they are still high-priced. The results of a twelve months' careful observation prove that the extent of the breaking of the mantles varies with the care exercised in placing the shade, the manner of lighting, the skill of the lighter, &c. The average life of a mantle is about 68 days: this represents, therefore, an annual outlay of 5.37 mantles per burner. The saving otherwise realized is quite sufficient to pay for breakages of mantles and glasses and to provide against accidents. The substitution of the Auer-Bec for the butterfly burner has therefore resulted in three times more light without increasing the annual charges for maintenance."

With reference to the arc lamp, M. Marechal adds to the above that "the arc lamp is still more advantageous than the Auer-Bec, but it must not be forgotten that, where electricity has been installed, a great increase in the annual expense of lighting has followed. With the Auer-Bec, however, the lighting of ordinary streets is materially improved without any extra cost being incurred for maintenance. Lighting by incandescent gas for public thoroughfares seems, therefore, to be the most economical system. It is evident, too, that the light will be greatly improved in the future. Experiments are taking place on all sides which will doubtless result in the general adoption, at a cheap rate, of a light worthy of Paris."

Pumping Plants for Water Works.

THE installment of a pumping plant for a municipal water-supply may often cost far less at the outset than the necessary conduits for bringing water from a source whence it will derive sufficient pressure from a natural head. But, when installed, a pumping plant is a constant source of current expense, which, in many cases, amounts to much more than the interest upon the cost, and deterioration, of a pipe-line; so that a pipe-line, costing several times as much as the pumping plant, may yet be more economical. Such has been the decision of the city council of Leeds, England, which now proposes to substitute reservoirs, pipe lines, and filtering-beds for its present pumping appliances.

The daily water consumption of Leeds was about 4,500,000 gallons in 1866. It is now 15,000,000 gallons, and is increasing at the rate of about 1,000,000 gallons a year. As some thirty miles of pipe-line will be required to obtain an adequate supply, including sufficient storage capacity, and as only three miles of this pipe-line will be necessary to avoid pumping, it has been decided to abandon the pumping wholly and permanently. In coming to this decision, said a member of the council (reported in the *Journal of Gas Lighting*, Oct. 13), the committee of the council was influenced by the ever-increasing cost of pumping, and their desire that pumping should be abolished for all time, seeing that the only necessary work additional to what must in any case be done to abolish this pumping forever was some three miles of pipe-line, valued at £12,000 to £14,000; whereas the cost of continuing pumping would certainly be nearly £5,000 per annum.

Incineration of Garbage.

AT the annual meeting of the Sanitary Inspectors' Association Dr. Spottiswoode Cameron and Mr. George Darley gave a statement of the cost of running the refuse-destructors at Leeds, which is a valuable addition to the current literature of the subject. These data are presented in tabulated form below. There are four destructors now in use in Leeds; one of these having been recently put into operation, the data are confined to the three destructors that have been working pretty steadily for about three years, although never yet worked up to their full capacity.

The paper in which these data were presented was printed at length in the *Sanitary Record* (Oct. 9). The system as carried out under the direction of weighmen solely responsible to the superintendent of the refuse-removal department has enabled the department to obtain data very closely approximating accuracy.

During the three years in which the destructors have been at work, 181,645 tons of garbage have been burned. The actual cost of cremation, excluding interest on land, deterioration, and salaries of the superintendent and his staff, has been, for the time and quantity named, £14,773, which gives a mean rate of 19.53d. per ton. The interest on the cost of buildings, at four per cent., amounts to about 3.85d. per ton. The interest on the cost of land for the time and quantity specified amounts, at the same rate, to 1.27d. Four per cent. is reckoned too high for the land. Two per cent., substituted, reduces the cost to almost exactly two shillings per ton. In tabulated form it is

	Per ton. d.
Working, less returns.............	19.52
Buildings and plant, interest, four per cent.....................	3.85
Land, interest at four per cent.....	1.27
	24.64

The destructors have of late been more costly, and the land varies also in value. The cost of working the destructors has also varied.

Experiments on work done by destructor cells at Leeds, by Messrs. Durley and Putman. Area grate, each ce 7ft. by 5ft.; jets, two; pressure, 60 lb. Wages at rate of ˙ for eight hours.

Date.	Number of cells.	Duration of experiment.	Diameter of steam jets.	Frequency of clinkering.	Tons burnt.	Temperature of flue.	Menemployed.	Wages of firemen.	Per cell, day. Tons burnt.	Men employ'd	W'ges paid.	Cost per ton, burnt. Wages. Pence.	Clin per cent
1894.				Hours.		Fah.					s d.		
June 12th.	4	12 hours.	$\frac{1}{8}$in.	Every 2.	20·4	1500 deg.	3	15s.	10·20	1·5	7 6	8·82	36
June 13th.	4	12 ,,	No jets.	,, 2	16·5	1050 deg	3	15s.	8·25	1·5	7 6	10·91	35
June 25th and 26th.	4	24 ,,	$\frac{1}{2}$in.	,, 1.	63 1	Frequently 2000 deg., i e., melted copper.	12	60s.	15·78	3	15 0	11·41	35
June 26th and 27th.	4	24 ,,	$\frac{1}{4}$in.	,, 1.	60·15	Ditto.	12	60s.	15·04	3	15 0	11·97	32
June 27th and 28th.	4	24 ,,	$\frac{1}{8}$in.	,, 1.	54·35	1500 deg.	12	60s.	13·59	3	15 0	13·25	37
June 28th and 29th.	2	24 ,,	$\frac{1}{4}$in.	,, $\frac{1}{2}$	53 5	Frequently 2000 deg	12	60s.	26·75	6	30 0	13·46	35

"At Arnley road the total cost for the three years, estimated in the same way, was 23.56d. per ton burned. The item of working expenditure was 18.91d. Adding the interest on the capital spent on the plant (but exclusive of land) up to 25th March, 1895, it comes to just under 21.94d., and, including land, to 23.56d. per ton.

"At the oldest of the three destructors the total cost during the three years, including interest on capital, and everything except superintendence, was at the rate of 28.54d. per ton. The working cost, exclusive of capital, was 22.65d., and, including the capital on buildings only, 27.56d. This destructor has not been fully worked, as a portion of the less offensive refuse that would otherwise have been incinerated there has been used on parts of the public parks for filling, where it was desirable to raise the land by soil-making material. This accounts for the increased cost of destruction per ton at this station.

At the newest of the three destructors (Kidacre street) the expenses, exclusive of capital, were 17.98d. per ton, as against 22.65d. at Beckett street, and 18.91d. at Arnley road. The costs at the three destructors are tabulated as follows:

	Arnley Road. Pence per ton.	Beckett St. Pence per ton.	Kidacre St. Pence per ton.
Working, less returns	18.9111	22.651	17.983
Interest, 4 per cent... on plant	3.024	4.943	4.090
Interest, 4 per cent. on land............	1.624	.945	1.052
Totals.... ...	23.559	28.539	23.125

The destructors are capable of burning a much larger amount than they now actually consume. It has been found that, when ten tons per cell are burned per day, the fireman's wages cost is reduced to less than 9d. per ton.

The data of experiments, which show variations in wages cost per ton as related to amount daily burned in each cell, are shown in the table herewith presented.

Explosive Nature of Acetylene.

It seems certain that acetylene, whether used for illumination by itself or as an enricher for ordinary illuminating gas, must be handled with caution. Recent disastrous explosions, some account of which will be found in our department of Scientific Miscellany for this month, have demonstrated the fact that explosions of acetylene may occur from causes that, at present, can only be guessed at.

The French *savants*, Berthelot and Vieille, have been experimenting to ascertain the needed precautions for storing and handling this material in a commercial way, and have published some notes upon the subject in the *Comptes Rendus*. They found that, whether ignited by the electric spark, by mercury fulminate, or by a heated wire, the decomposition of acetylene under normal atmospheric pressure extends only to a short distance; but, if the gas be compressed, the extent of the decomposition, and the consequent violence of the explosion, increase in a ratio much exceeding that of the increase in pressure. Even at two atmospheres the decomposition is complete. This will have to be taken into account by all who are scheming to compress the gas into iron bottles for general commercial distribution and use. M. Pictet, one of the most experienced and skilful manipulators of compressed and liquefied gases in the world, has already had a man killed and a part of his works in Paris destroyed by the explosion of acetylene in a tank such as is used for conveying liquefied carbonic acid, and which was of enormous strength.

The British Royal Commission declares the new red sandstone to be the most effective filtering material known, every trace of organic matter being converted into innocuous compounds. Its extent in England and Wales is 10,000 square miles. At Liverpool, four public wells yield an unvarying quantity of 6,000,000 gallons of water daily, of a quality which has remained uniform since 1851. At Nottingham and at Wolverhampton waterworks individual wells yielded over 3,000,000 gallons daily for a long period.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

GAS SUPPLY.

8670. Observations on the Construction and Working of Regenerator Settings. W. J. Jenkins (Read before the Eastern Counties' Gas Managers' Assn. The diversity of retort settings, advantages and disadvantages of different methods, practical considerations and useful modifications). Am Gas Lgt Jour—Oct. 12. 4400 w.

9034. The Bunsen Flame. Dr. W. H. Birchmore (Studies of the properties of the Bunsen flame, comparison with those of the flame of the Welsbach burner and an account of two series of experiments with a burner in which supply of gas and air were under perfect control). Am Gas Lgt Jour—Nov. 2. 4800 w.

9035. The Address of President Humphreys (A discursive but exceedingly practical address, for the most part dealing with administrative problems). Pro Age—Nov. 2. 11000 w.

9036. A Discussion of Various Methods Employed in the Introduction of Gas Stoves. Charles H. Nettleton (Read at the St. Louis meeting of the Am Gas Lgt Assn. Facts and practices in relation to the use of gas stoves, particularly gas cooking stoves). Pro Age—Nov. 2. 7000 w.

9037. Inclined Retorts Up to Date. Frederick Egner (Read at the St. Louis meeting of Am Gas Lgt Assn. Causes of failures in the use of inclined retorts and the success which has finally been achieved by the system. Illustrated). Pro Age—Nov. 2. 7500 w.

9038. The Separation of Water Gas Tar. Alten S. Miller (Read at the St. Louis Meeting of Am Gas Lgt Assn. Outline of a simple and inexpensive method of separating oil residuum or tar from the water as it comes from the scrubbers). Pro Age—Nov. 2. 1000 w.

9039. A Modern Retort House. William S. Miller (Illustrated description of No. 5 retort house of the Cincinnati Gas Light and Coke Co). Pro Age—Nov. 2. 5000 w.

9040. Some Experiments in Interior Illumination. C. H. Page, Jr. (Illustrated description of photometric tests). Pro Age—Nov. 2. 1200 w.

SEWERAGE.

8677. Shipley Run Sewer, Wilmington, Del. T. Chalkley Hatton (Illustrated description). Eng Rec—Oct. 10. 1500 w.

STREETS AND PAVEMENTS.

*8660. The Importance and economy of Pavement Maintenance. S. Whinery (Showing that municipal pavements should be protected properly and repaired promptly under the supervision of responsible contractors). Eng Mag—Nov. 3800 w.

*8764. Sketch History of Road Paving. W. J. E. C. (Interesting facts relating to ancient and modern roads). Ill Car and Build—Oct. 9. 2500 w.

*9007. Advantage of an Asphalt Testing Laboratory. N. P. Lewis (Outline of work done in a small laboratory in Brooklyn). Munic Engng—Nov. 3000 w.

*9008. Specification Requirements for Asphalt, Asphalt Mixtures and Tests. A. W. Dow (Definitions of terms used in specifications, and an attempt to advance towards a standard specification for an asphalt mixture). Munic Engng—Nov. 5400 w.

*9009. Repairs of Asphalt Pavements. E. B. Guthrie (Classification and general discussion of asphalt pavement repairs). Munic Engng—Nov. 2200 w.

*9011. Testing Paving Brick. A. D. Thompson (Character of bricks suitable for paving, the necessity of testing to make sure of quality, and the essentials for satisfactory testing). Munic Engng—Nov. 3600 w.

*9012. Paving Streets with Brick. S. J. Hathaway (Account of brick paving as practiced in Marietta, O.). Munic Engng—Nov. 1900 w.

WATER SUPPLY.

8716. The New Croton Dam (Illustrated description). Sci Am—Oct. 17. 900 w.

*8756. Water Supply and Sewerage as Affected by the Lower Vegetable Organisms. Clarence O. Arey (A study of bacterial life in relation to sewerage, water supply and filtration). Jour Assn of Eng Soc—Sept. 3400 w.

*8859. Leicester Water Works (Illustrated detailed description). Eng, Lond—Oct. 9. 2300 w.

8883. Syracuse and Its Water Supply (Illustrated description). Fire & Water—Oct. 24. 2000 w.

*8916. Contamination of Our Municipal Water Supplies. Frank J. Thornbury (A popular exposition of what renders a water supply bad or good, and upon the rarity of really safe water supply). Chau—Nov. 2500 w.

8934. The Water Supply System of Salt Lake City, Utah. W. P. Hardesty (Illustrated description). Eng News—Oct. 22. 4000 w.

*9004. Notes on Sinking, Timbering and Refilling Concrete and Puddle Trenches for Reservoir Embankments. William Watts (The paper gives an epitome of results of the author's experience in carrying out large reservoir undertakings). Eng, Lond—Oct. 23. 4300 w.

9020. The Manhan River Water Supply of Holyoke (Illustrated description). Eng Rec—Oct. 31. 1200 w.

†9042. A Practical Plan for Sand Filtration in Philadelphia. Allen Hazen (Deals with the possibilities of filtration, which are considered in relation to present sources of supply, sites for filters, system of distribution, reservoirs, consumption of water, nature of proposed filtration, population, magnitude of supply, cost estimates, with conclusions favorable to the practicability of the proposed system). Jour Fr Inst—Nov. 6500 w.

MISCELLANY.

8675. English Sewage and Water Works. W. M. Watson (Illustrated description of the ferozone and polarite system of sewage and water filtration). Can Eng—Oct. 1200 w.

*8704. Clean Streets and Their Benefits. La Salle A. Maynard (Advantages of clean streets, and a comparison of European and American systems of street cleaning). Am Mag of Civ—Oct. 1000 w.

*8763. Cost in Leeds of Destroying Refuse by Heat. Dr. Spottiswoode Cameron and Mr. George Darley (Tabulated data and explanatory description of experiments to determine cost). San Rec—Oct. 9. 800 w.

*9006. Meeting of American Society of Municipal Improvements (A critical review). Munic Engng. Nov. 1700 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Railway Extension in Bengal.

It has been justly said that, where the railway penetrates, civilization immediately follows, and we may soon expect to see a marvellous transformation in some parts of British India. *The Indian and Eastern Engineer* outlines an important scheme of railway extension favored and urged upon the attention of the government of Bengal by the Bengal chamber of commerce. This question of railway extension has been before a committee of the chamber of commerce for a considerable period, and has been the subject of much careful consideration. Consultations by the committee with committees of associations connected with the chamber have been held, these associations representing industries whose continued success and development depend upon an energetic railway policy on the part of the government. The secretary of the Bengal chamber of commerce addressed to the government of Bengal a letter setting forth the requirements of the country as regards railway extension, the occasion of the letter having been a conference on railway schemes, held at Simla and presided over by the viceroy. The conference was participated in by members of the department of public works and finance, and specialists from other departments. The primary object of the conference was the consideration of schemes for feeder lines, and an effort to form a comprehensive idea of the requirements of the country in the matter of railway extension, and of the way in which such requirements could be met.

Without attempting to follow out in detail the schemes favored by the Bengal chamber of commerce, we will here speak of only one, which, if carried out, must inevitably affect materially the commerce of the civilized world. This project is for a railway line between Mogulserai and a point on the Bengal-Nagpur line near Purulia or Sini. Those who take sufficient interest in the subject to look up the geography of the country between the points named will see that, whether the projected road should connect these points by crossing the Sone near Dehri, or curve under Rhotas to Daltongunge and so on to the eastward, it can not fail to be an important addition to the railway facilities of the country, or to open up a commerce the value of which would be immense. By this line the whole of upper India could be supplied with coal mined one hundred and seventy miles from Mogulserai. The effect would be the development of new and needed industries in the whole of upper India, and especially a great iron industry.

In arguing for this line as opposed to a scheme for doing the same work by branches from the Grand Chord Line of the East Indian Railway, the committee of the Bengal chamber of commerce bases its protest on "the axiom in railway economies that whatever can be done by a direct line should not be done by branches; the reason being that the work done by branches must, of necessity, be partial, be severely localized, and be more expensive."

The projected line favored by the committee would skirt or pass through four great coal-fields, and nearly approach a fifth. The four fields which would be skirted or passed through are the Ramgarh and Bokaro field, the Karanpura and Baragaon field, the Auranga field, and the Daltongunge field. The Hutar field lying a little to the southwest of Palamow could be reached by a short branch from the main line.

Thus would be strung together five great coal-fields, while all along the line are deposits of iron ore of a superior quality. Tests show that some of this ore will yield from thirty-five to sixty per cent. of metal. Some magnetic ore yielding seventy per cent. of metal has been found. Limestone is abundant along the route, so that all the requirements for cheap and abundant production of iron are grouped in an unusual degree. It is, therefore, believed that a great and attractive opening for capital exists in the region through which it is proposed to run this line.

No intelligent person can fail to perceive the possibilities this enterprise would open up. To us it seems that the long-slumbering orient is at last awakening to take its place in the grand march of civilization. Japan has led the van in this progress, but it does not seem either impossible or improbable that China and other oriental nations will ere long be found in step with the mighty tread of an advance that can be neither evaded or resisted.

By the carrying out of the railway scheme we have outlined, 1,100 square miles of coal-fields, estimated as capable of producing 12,000,000,000 tons of coal, will be opened up. Other important extensions are urged upon the attention of the government, and it is evident that the mercantile interests of Bengal are keenly alive to the commercial possibilities existing within the bounds of that great dependency.

Compressed-Air Surface Cars in New York.

OF the experiment with compressed-air motors on the Fort Lee branch of the Third avenue cable railway in New York city, the *American Machinist* (Oct. 22) says that its success has been complete. The two compressed-air motor cars placed upon the line August 3 have run since that date so monotonously well that there is nothing else to be said of their operation. The length of the round trip is four and three-eighths miles. These cars, running regularly, like the cable cars on the same line, says our contemporary, "have not only run without accident, but without incident. The greatest thing of all that can be said about them is that there is nothing to say." Our contemporary is an enthusiastic believer in the possibilities of compressed air as a transmitter of power, and, for the past year or so, has paid much attention to the increasing applications of compressed air in the various industries. Should its enthusiasm be suspected of coloring any statement made by it with reference to the Hardie motor cars on the road named, this suspicion will, upon investigation, prove entirely unfounded. The facts of the trial of these cars are exactly as stated, and they form a unique chapter in the history of compressed-air motors for railway purposes.

In the first place a person riding on one of these cars would detect very little, if any, difference in the speed, motion, or comfort of the vehicle as compared with a cable or a trolley car. If he noticed any difference at all, it would be in favor of the air-motor car, and would lie in the absence of jerks in starting and stopping. In the latter respect the cars are a marked improvement over cars hither employed.

For some reasons not made public the cost of running these cars is, as yet, withheld from publication, although a careful record has been kept. It is, however, given out that the experiment indicates a highly satisfactory economy. Probably commercial reasons exist for not stating the exact figures. Be this as it may, there seems good reason to believe that the system of propelling cars by compressed air has been shown to be completely practicable, both from an engineering and a commercial point of view.

If this prove true, there are those now living who will remember earlier attempts to do the same thing, the difficulties then encountered, and the failures. These witnesses of the former experiments will, as a rule, attribute the present success very much to increased engineering and mechanical resources, but still more to the dogged obstinacy and persistence with which some of the best engineering talent has insisted on an affirmative answer to the question of the practicability of compressed-air motors for street-car propulsion.

Advances in Street-Railway-Car Building.

THE progress that has been made in street-railway-car building forms the subject of an illustrated article occupying eight pages of the *Street Railway Journal* for October. From this article one gains a good idea of the care and thought which have been bestowed upon the equipment of street railways. We are informed thereby that "in no one department of street-railway operation have more changes been made during the past five years than in the style of cars used." The tendency during this period has been toward more substantial construction. At the same time more attention has been paid to decoration. The experience of the past has taught the lesson that the best "economy lies in the direction of carefully and strongly built cars." Especially has this lesson been enforced by experience in electric-railway service.

Two modes of construction have prevailed. One class of builders have based construction upon precedents and data derived from steam-railway cars. Another class has adhered to the model of the old sixteen-foot horse-car, under the belief that transverse strains in street cars preponderate over longitudinal strains, and, as the old-style horse-car was modeled after the street omnibus, or stage coach, the cars of the latter class of builders show a marked resemblance to those now nearly extinct vehicles. Both classes of makers are, however, studying to reach a substantial construction, in which effort iron and steel have been freely substituted for wood.

Not only has decoration of the interiors of street cars been carried to an extent very much beyond that of the street cars of only a few years ago, but the seats are more luxuriously upholstered. With the electrically-propelled cars electric lighting of cars has also come, and in this respect the modern street car is immeasurably in advance of the horse-car now passing into ancient history.

The introduction of mail, express, and parlor cars on the street railways, particularly on the suburban railways, has proved a welcome innovation. The introduction of the beautifully-finished and gorgeously-lighted special cars for pleasure parties has demonstrated that it will pay most of the roads in large cities to cultivate this class of traffic.

Street-railway cars are also made more spacious and commodious than they have ever been at any previous period. The trolley system will handle cars very much too heavy for horse propulsion. This makes entirely practicable cars capable of holding a much larger number of passengers than could once be carried in street cars, and the earning capacity of a street-car line of any given length with a given number of employees has been very much increased by this change.

Many other interesting particulars are given in the article thus briefly reviewed. In looking it over those not entirely familiar with street-car building will feel some surprise at the variety of designs exhibited in the illustrations, wherein the work of a considerable number of prominent car builders is represented.

High Speed on Curves.

MR. JOHN RIEKIE, writing from Sukkur, India, to *The Engineer* (London), expresses views regarding the safety of fast running around railroad curves which will be surprising, at least to the "travelling public," in whose interest especially he writes.

His letter is called forth by a leader on the Preston accident, appearing in *The Engineer*, and containing the sentence; "The only other cause available was running around the curve at too high a speed."

Mr. Riekie says: "Now, I deny that high speed round a curve will cause a derailment. I am treating the word derailment as referring to the flange of the leading wheel mounting the outer rail. The result of an accident, when going at high speed, is most disastrous, but it is in my opinion most regrettable that the travelling public should be taught that it tends to derailment, when it is the reverse in actual practice. A little further on in your article you show that the load may be fifty per cent. more on the outer wheels than on the inner ones, and that the extra loading to the outside promotes safety. How, then, can high speed cause derailment? During my wide experience of nearly thirty years I have never known a single derailment having occurred owing to speed; the reverse is the case, and I have known for an actual fact that drivers have had to get up a speed of twenty miles to prevent a derailment when it was impracticable to go round a curve at five miles an hour without derailing.

"I should like to quote cases that might help to show that high speed does not tend to derailment. First, in 1879, when the extension of the Punjab Northern State Railway was being made beyond Jhelum, Mr. Avern, the engineer-in-chief of the extension, consulted me as to the extraordinary behavior of an engine that was lent to him for ballasting purposes. The tender of this engine got derailed almost daily when an official was on the train, not so when the driver was by himself. There was a restriction of speed on this curve; I explained what occurred at high speed, and that it was quite possible that the driver, when alone, got up a fairly high speed before going round the curve.

"Second, on a certain section of the North-Western Railway a part of the line on the 1 in 25 grades had been laid with curves having 819 feet radius, the super-elevation of which had by an error been made ¾ inch in place of 3 inches. When this part of the line was inspected by the officials, the error was noticed, and a remark was made that it would be impracticable for a runaway wagon to go down the grade without derailing. I ventured the suggestion that it might capsize, and that the want of cant would enhance the safety of the vehicle from derailing. This was considered preposterous, and I got permission to try the experiment. Needless to say, when the experiment was made, the vehicle ran round with perfect safety. The speed attained was about fifty-five miles an hour. I do not know what percentage of weight was on the outer wheels when on the curve,—probably ninety per cent.; but surely it stands to reason that, if the weights on the outer wheels increase with the speed, it is utter nonsense to expect the flange to be able to climb. Here, then, are two practical facts—I have known very many similar—to prove that high speed will not tend to derailment."

It seems as if, from such a store of facts, Mr. Riekie might have selected stronger confirmations of his argument; for one of his instances is susceptible of various explanations, and the other is purely negative. On the other hand, any observer of railroad accidents can recall numerous cases in which vehicles were derailed on attempting to pass, at unusually high speed, over curves which they travelled with ease and safety at low speeds.

With all respect to Mr. Riekie's experience, it seems likely that he has appreciated one of those half-truths which are so dangerous. The increase of centrifugal tendency with increased speed does, of course, tend to throw additional weight on the outer rail, and, to that extent, to oppose the tendency of the wheels to mount on that side.

But the superimposition of weight is only an indirect or resultant effect; the other and more important component into which the centrifugal force is resolved is an outward pressure of the wheel-flange on the rail-head. Given the factors of speed, weight, curvature, and wheel and rail section, it should be no difficult matter to determine the point at which the outward moment would overcome the extra load on the outer rail, and a "derailment," in Mr. Riekie's strict and limited sense, would occur.

In practice, of course, some defect of equipment or track surface, or sudden inequality of pull, might bring the catastrophe before the theoretical limit was reached.

But there is another possibility which Mr. Riekie's technical definition would ignore, and that is that the track may fail, under the lateral pressure, before the point is reached at which the wheels climb the rail. To the passenger who experiences the consequences, the question whether a broken or spread rail is properly "a derailment" will have little importance, and even the coroner's jury will hardly go into the niceties of the distinction. Something also might be said with reference to wear of flanges as tending to derailment when the centrifugal force is pressing the flange strongly against the curved surface of the rail.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

CONSTRUCTION.

8726. The Proposed Chesapeake and Ohio Improvements at Richmond (Photographs, map and partial details, with description of an important piece of track elevation and increase of traffic facilities). R R Gaz—Oct. 9. 4000 w.

8826. Electric Roads Near Cleveland (Brief historical review, with map and notes of current work). R R Gaz—Oct. 16. 900 w.

*8860. The Lanarkshire and Dumbartonshire Railway (Map and brief description of the line, bridges, &c.). Eng, Lond—Oct. 9. 800 w.

†8961. Steel Sleepers in Queensland. John Alfred Griffiths (Describes the construction of the Normanton-Croydon Railway, 94 miles in length). Ind and East Eng—Sept. 19. Serial. 1st part. 2300 w.

†8962. Railway Extension in Bengal (Extract from a letter addressed by the Secretary of the Bengal Chamber of Commerce to the Government of Bengal. Information regarding proposed roads). Ind and East Eng—Sept. 19. 2400 w.

8987. The Siberian Railroad (Some of the more important particulars of this great enterprise). R R Gaz—Oct. 23. 2000 w.

9055. Double Tracking on the Chicago & Northwestern Ry (Construction of another track, between Baraboo and Madison, with improvement in grades and straightening of alignment. Illustrated by diagrams). Ry Rev—Oct. 31. 1600 w.

9056. Longitudinal Sleepers in Austria (From an interesting paper presented by W. Hohenegger before the International Ry Congress. Illustrated account of construction). Ry Rev—Oct. 31. 1000 w.

*9120. Glasgow Central Railway (Illustrated description of the portion of the road from Glasgow Cross to Dowsholm and Maryhill). Eng Lond—Oct. 30. 2200 w.

ELECTRIC AND STREET RAILWAYS.

*8781. Test of Railway Insulators. L. A. Murray (A report of a test of glass and porcelain railway insulators made in the Electrical Engineering laboratory of Cornell University). Sib Jour of Engng—Oct. 1400 w.

8802. Compressed Air Surface Cars in New York (Present status of this system of car propulsion). Am Mach—Oct. 22. 1400 w.

†8805. The City of St. Louis and Its Transportation System (A full discussion of the St. Louis street railways with respect to relation to distribution of population, finance, equipment, power, track, &c., with illustrations, diagrams and tables). St Ry Jour—Oct. 20000 w.

†8806. The Great Street Railway Properties of America (A tabulation of mileage, capitalization, liabilities, receipts and charges of twenty-nine important systems, with descriptive comment). St Ry Jour—Oct. 7000 w.

†8808. The New York State Street Railway Association (Brief report of annual meeting, with papers and reports presented). St Ry Jour—Oct. 12400 w.

*8809. Trolley Express Service in Brooklyn (A brief description of the system and development of the business). St Ry Rev—Oct 15. 600 w.

*8810. Trolley in Egypt. (An account of the inauguration of the system in Cairo). St Ry Rev—Oct. 15. 600 w.

*8811. Electric Car Brake Adopted by Chicago City Railway (Description and illustration of the device). St Ry Rev—Oct. 15. 700 w.

*8812. Street Railways of St. Louis (A review of the system and of characteristic and important features). St Ry Rev—Oct 15. 8800 w.

*8813. A Few Notes on Early Electric Railway Work in Pittsburg. Leo Daft (Illustrated reminiscences). St Ry Rev—Oct. 15. 3500 w.

*8814. Progress on the Boston Subway (Account of progress and of peculiar features in the work, with map and illustrations). St Ry Rev—Oct. 15. 400 w.

*8817. Cable Traction in the Isle of Man (Illustrated description of the installation, equipment and operation of the Upper Douglas Tramway, with many details). Ry Wld—Oct. 2400 w.

*8820. Tramway Permanent Way, as Adaptable for Mechanical Traction. John S. MacGregor (A detailed consideration of the construction of what may be deemed at the present time a thoroughly good permanent way). Ry Wld—Oct. 4000 w.

*8824. Liverpool Overhead Railway. S. B. Cottrell (Abstract of a paper read before the British Assn. Detailed description of the line, which is partly elevated and partly underground, and operated throughout by electricity). Elect'n—Oct. 9. 4400 w.

8825. How Electric Railroad Eqipment May Be Simplified (Shows the irregular apportionment of recent improvements in design, and explains and illustrates the proposed simplification in arrangement of apparatus). R R Gaz—Oct. 16. 2800 w.

8841. An Experiment with an Improvised Booster on Street Railway Feeders. Robert P. Brown (Account of the reasons leading to the adoption of the system, and description of the plant as installed, with map, plan and load curves). Elec Wld—Oct. 24. 1800 w.

8842. The Electric Underground Road in Budapest. Josef Herzog (A descriptive account of the inception of the project, the construction of the road and installation of power. Illustrated). Elec Wld—Oct. 24. 1300 w.

8843. Electric Railway Construction. Albert Vickers (A review of modern standards, chiefly of track. Illustrated). Elec Wld—Oct. 24. 2000 w.

8845. Note on the Pressure of the Trolley Wheel Against the Wire. Herman S. Hering (A discussion of the effect on sparking, with argument in favor of high pressure, with notes of tests and the results). Elec Wld—Oct. 24. 1400 w.

8846. Some Prominent Features in Electric Railway Construction (Points of special engineering difficulty of interest in construction on roads near New York City). Elec Wld—Oct. 24. 1200 w.

8847. A New Method of Detecting Waste of Power in Electric Railways Harold P. Brown (Description of the method and exposition of the importance of the results in economic regulation of the power-station). Elec Wld—Oct. 24. 1600 w.

8849. The Evolution of the Street Railway Motor. Charles T. Child (Historical review, with description and illustrations of successive types). Am Elect'n—Oct. 3500 w.

8850. Steam Engines for Electric Railway Service (Discussion, with illustrations of various types). Am Elect'n—Oct. 4000 w.

8862. The Fairmount Park Transportation Co., of Philadelphia, Its Plans and Work (Illustrated descriptive account). Elec Eng—Oct. 21. 1500 w.

8863. St. Louis Electric Railway Power Stations (Plans and descriptive accounts of several power stations). Elec Eng—Oct. 21. 1500 w.

8872. Street Railway Easement Curves. Charles A. Alden (Illustrates the racking effect of curves on long cars with short wheel-base, and argues the importance of applying the spiral to street railway curves). Eng News—Oct. 15. 600 w.

8873. The Rowan Steam Street Car Motors in France (Descriptive account of the equipment and operation). Eng News—Oct. 15. 600 w.

8875. The Street Railway Track of the Future (A discussion of present problems and practice, and of essentials of the ideal). Eng News—Oct. 15. 1800 w.

8935. Momentum Friction Brake for Electric Cars (Illustrated description of a recent invention by W. G. Price, of Chicago, which has had six months successful operation in actual service). Eng News—Oct. 22. 350 w.

8939. The Third Rail Electric System of the New York, New Haven and Hartford R. R. (Illustrated description). Eng News.—Oct. 22. 600 w.

*8951. Electric Traction. R. H. Smith (The reasons why electric transmission for railway purposes has been delayed in England, the importance of electrical engineers acquainting themselves with the experience gained in America. Frequent reference is made to information from the Street Railway Journal). Eng Lond—Oct. 16. 4000 w.

8956. President Littell on the Street Railway Situation (Abstract of address delivered at St. Louis).

8957. Storage Batteries in Use by the Union Traction Co., Philadelphia (Brief illustrated account of the installation just completed for the Union Traction Co). Elec Eng—Oct. 28. 500 w.

8958. The Modern Power House. Richard McCulloch (Paper read before the Am. St. Ry. Assn., St. Louis. The first part discusses location, building and steam generating apparatus). Elec Eng—Oct. 28. Serial, 1st part.3700 w.

8959. Track and Track Joints, Construction, Maintenance and Bonding. M. K. Bowen (A discussion of the subjects mentioned in title. Read before the Am. St. Ry. Assn., St. Louis). Elec Eng—Oct. 28. 2800 w.

8960. How Can the Revenue of Street Railways Be Increased? C. Densmore Wyman (Read before the Am. St. Ry. Assn. Offers suggestions, advises advertising, making service attractive, discusses the transfer system). Elec Eng—Oct. 28. 3800 w.

8971. Modern Overhead Construction for Electric Railways. Benjamin Willard (Abstract of a paper read at the annual convention of Am. St. Ry. Assn. Discusses methods of construction and gives the writer's preferences and reasons). Eng News—Oct. 29. 3000 w.

8972. Spiral Curves for Street Railways. Charles A. Alden (Tables designed to meet most cases arising in usual practice, with explanations and remarks). Eng News—Oct. 29. 2400 w.

*9010. Modern Street Railway Track Construction on Asphalt Paved Streets. F. W. Cappelen (Description of work in Minneapolis. The street railway company aim to construct a first-class track in every respect). Munic Engng—Nov. 2200 w.

†9068. Construction and Maintenance of Electric Railway Tracks. George H. Neilson (Abstract of paper read before the Penna. State Assn. Treats briefly of foundation, concrete, ties, rails, splices, frogs, &c., and of points of interest in the construction of suburban roads). St. Ry Jour—Nov. 2000 w.

†9069. Street Railway Trucks. John N. Akarman (The object of the paper is to give hints to street railroad men which will enable them to decide what type of

truck is best adapted to the purpose. Read at the St. Louis Convention). St Ry Jour —Nov. 3000 w.

†9070. The Selection and Management of Employees. W. F. Kelly (Suggestions offered from large experience, observation and inspection. Read at St. Louis Convention). St Ry Jour—Nov. 3000 w.

9077. How to Increase the Working Efficiency of Railway Motors. William Baxter, Jr. (A review of the progress, statement of principles, and account of the operation of motors of the writer's own design, in which the principles referred to were adopted). Elec Wld—Nov. 7. 2500 w.

9087. Cable Car Brakes. Paul Synnestvedt (A letter to the editor criticising the form of brake commonly used). Ry Mas Mech—Nov. 1100 w.

*9117. The Bristol Electric Tramway (Illustrated description of important changes and developments). Engng—Oct. 30. 2000 w.

*9138. A Review of Electric Traction (Extended extract of a voluminous paper by M. E. de Marchena, with comments). Elect'n—Oct. 30. Serial, 1st part. 4000 w.

*9139. The Effect of Insulation Resistance and Capacity on the Absolute Potentials in Alternate Current Systems. A. Von Ettinghausen and G. Ossana (From the Zeitschrift fur Elektrotechnik. The paper is chiefly devoted to the consideration of three-phase circuits, but the methods are also applicable to single and two-phase alternating systems). Elect'n—Oct. 30. 2400 w.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

8724. Official Report of the 27th Annual Convention of Master Car and Locomotive Painters' Association (Full report of officials, committees, &c., and discussions. The topics include compressed air for burning off cars, flatting of varnishes, painting locomotive jackets and galvanized iron, the enamel process, locomotive painting, spontaneous combustion in paint shop, painting super-heated parts, &c.). RR Car Jour—Oct. 60000 w.

8725. A New Baldwin Locomotive for the Lehigh Valley Railroad (Sectional drawings and details of new wide-firebox engine for Lehigh Valley RR.). RR Gaz—Oct. 9. 500 w.

8727. A 100-Per Cent. Rail Joint. M. W. Thomson (Brief discussion of the theory of the joint and splice, and illustrated description of an improved device). RR Gaz—Oct. 9. 500 w.

8733. Cast Iron vs. Steel Tired Wheels. R. P. C. Sanderson (From a paper read before the Southern & Southwestern Railway Club. A comparison of merits, defects and economy, with argument for the chilled wheel. Also editorial). Ry Rev—Oct. 10. 10500 w.

*8819. An Anglo-American Express Engine (Illustrated description and details of an English built express locomotive approaching closely the American type). Ry Wld—Oct. 500 w.

8844. The Heilmann Locomotive. H. Ward Leonard (An illustrated description of the type, with some dimensions and performance figures). Elec Wld—Oct. 24. 1700 w.

*8848. The London Engineer's View of the Locomotive Question (A review of the question of heating surfaces, with general tone unfavorable to the efficiency of the American type). Engng Mech—Oct. 900 w.

*8942. Carriages for Local Passenger Traffic; Dutch Central Railway (Illustrated description of carriages used by the Dutch Central Railway Company at Utrecht). Engng—Oct. 16. 400 w.

*8967. New Equipment on the Baltimore & Ohio Railroad (Dimensions, with photographs, of several classes of engines for road named). Am Eng & R R Jour —Nov. 2000 w.

†8976. Car Roof Construction (Committee reports describing various styles of construction, with their characteristics and defects). Cent Ry Club—Sept. 1300 w.

†8977. Painted and Planished Locomotive Boiler Jackets (Committee report comparing first cost and maintenance expense. The figures and comment are generally favorable to painted jackets, but no conclusions are presented). Cent Ry Club—Sept. 500 w.

†8978. Car Repairs Under the New Rules of Interchange (A discussion of the interpretation of the rules and of repair problems arising thereunder). Cent Ry Club—Sept. 13000 w.

†8979. The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers. W. F. M. Goss (Full text of the original paper, showing decreased economy with increased rates of combustion, with charts, diagrams, description of apparatus and methods used in testing and the entire discussion). N Y RR Club —Sept. 17. 12500 w.

8982. A Water Tube Locomotive Boiler (An illustration from the C., M. & St. P. Ry. General description of construction with sectional drawings). Ry Rev—Oct. 17. 900 w.

8983. Arrangement of Wood-Working Machinery in Railroad Shops (An example of advantageous arrangement, taken from the C., M. & St. P. shops at Milwaukee, with plan). Ry Rev—Oct. 17. 900 w.

8985. A Locomotive Shop Travelling Crane, 5,000 pounds capacity (Description with drawings). Ry Rev—Oct. 17. 500 w.

8986. Some Examples of Metal Under-Frames from Foreign Countries (Illustrated descriptions of a number of designs used in European practice). R R Gaz—Oct. 23. 1800 w.

8996. Two New Trucks for Freight Cars and Tenders (Designs for metallic construction brought out by the Buckeye Engine Co., of Salem, O. Illustrations). Ry Rev—Oct. 24. 700 w.

*9001. Express Compound Locomotive, Imperial-Royal Austrian State Railways (Illustrated description of the most advanced type of express locomotive in Austria). Eng, Lond—Oct. 23. Serial, 1st part. 800 w.

*9003. Locomotive for London Expedition Railway (Detailed description with engraving and specification.) Eng, Lond —Oct. 23. 1200 w.

9054. Interesting Locomotives from the Baldwin Locomotive Works (Engravings and dimensions). Ry Rev—Oct. 31. 700 w.

*9061. Heavy Consolidation Engines for the Baltimore and Ohio Railroad (Illustration and general dimensions). Loc Engng—Nov. 300 w.

*9062. Mogul for the Great Northern Railway (Illustrated description). Loc Engng—Nov. 400 w.

*9063. Some New Ten-Wheelers for the Baltimore and Ohio (Illustration and general dimensions). Loc Engng—Nov. 500 w.

9098. Some of the Questions of Large Cars. E. W. Judd (Opinions from various sources, giving views of representative men in different departments of the service, showing the importance of the problem ...). RR Gaz—Nov. 6. Serial, 1st part. 3200 w.

9141. Preservation of Metal Frames for Tenders and Cars. E. M. Herr (Abstract of a discussion before the Western Railway Club, with diagram showing corrosion). Ry Rev—Nov. 7. 1100 w.

9142. New Eight-Wheel Locomotive—Chicago, Rock Island & Pacific Ry (Dimensions, with sections and description). Ry Rev—Nov. 7. 900 w.

9143. Automatic Lubricators for Locomotives (Abstract of paper by Mr. Parker, recently read before the Northwest Ry. Club, with editorial account of experiments on the St. Paul and Duluth RR.). Ry Rev—Nov. 7. 2700 w.

MAINTENANCE OF WAY AND STRUCTURE.

8874. Standard Track and Three-Rail Switch Work: Denver and Rio Grande R. R. (Description, with diagrams). Eng News—Oct. 15. 400 w.

9097. Track Elevation in Chicago (Illustrated description of the raising of the joint tracks of the Lake Shore and Michigan Southern and the Chicago, Rock Island and Pacific Railways). R R Gaz—Nov. 6. 2500 w.

SIGNALLING.

8729. Signal Rules for Trains Approaching Crossings (A comparison of English and American practice, with exposition and discussion, especially of the English system). RR Gaz—Oct. 9. 2200 w.

8940. A Double Blade Semaphore for Block Signalling on the Park Avenue Viaduct, N. Y. Central RR. (Description of special form of signal designed for special work). Eng News—Oct. 22. 1200 w.

TERMINALS AND YARDS.

8995. Railroad Terminal Stations. E. K. Turner (Read before the New England RR. Superintendents. The paper is confined to the consideration of stations for passenger traffic). Ry Age—Oct. 23. 4000 w.

TRANSPORTATION.

8731. Inter-Line Railway Tickets (Action of the General Passenger Agents' Association to secure protection against fraud and misuse). Ry Age—Oct. 9. 2800 w.

8735. Abolish the Ton-Mile (Editorial argument opposing the ton-mile, except as a basis of comparison, and granting it but limited value even then). Ry Rev—Oct. 10. 900 w.

*8950. Mineral Traffic on British Railways (Gives an idea of the extent and distribution of mineral products, their value, &c. Facts taken from report and mining statistics of the United Kingdom). Trans—Oct. 16. 1200 w.

8980. Train Dispatching by Telephone (Editorial treating the operator's strike on the C. P. R. R. as the possible originating cause of an extended movement toward train dispatching by telephone). Ry Age—Oct. 16. 1000 w.

8984. Rate Wars and Rate Control (Editorial argument for divorce of rate-making power from traffic management). Ry Rev—Oct. 17. 800 w.

*9026. Transport Problems in South Africa (Discusses the questions of ocean transport, railway communication, &c.). Trans—Oct. 23. 2200 w.

MISCELLANY.

8728. The Railroads of the United States in 1895 (Editorial abstract of the Interstate Commerce Commission statistics, with running comment). RR Gaz—Oct. 9. 1800 w.

8730. British Railroad Statistics in 1895 (Abstract of Board of Trade returns). RR Gaz—Oct. 9. 700 w.

8732. A Diagram for Hauling and Tractive Power of Locomotives (Designed to compare the power of locomotives having different sized cylinders and driving wheels, and to ascertain the effect of changing the dimensions. The construction of the diagram is explained and the formulae used are given). Ry Rev—Oct. 10. 600 w.

8734. A Unique Bituminous Coal Storage Plant (Illustrated description). Ry Rev—Oct 10. 1000 w.

*8815. A Thousand Millions in British Railways (A review and analysis of the Board of Trade report, especially as to capital additions and the traffic receipts for 1895). Trans—Oct. 9. 2200 w.

*8816. Railway Accidents and the Lessons They Teach (Analytical discussion of the Government report with notes of the progress in introducing safety appliances and also of hours of labor and wages). Trans—Oct. 9. 2500 w.

*8818. Railways of the United Kingdom (Analytical comparison of British railway returns, of construction, traffic and revenue, with charts). Ry Wld—Oct. 1000 w.

8821. Apprentice System—Union Pacific Railway (Regulations, form of application and illustrations of examinations). Ry Mas Mech—Oct. 2500 w.

8828. Fuel Loss Due to Forcing Locomotives (Editorial review of Prof. Goss's paper read before the N. Y. Railway Club in Sept., with diagrams). RR Gaz—Oct. 16. 1400 w.

†8836. Railways of Belgium (Historical review, table of mileage and balance sheet of receipts and disbursements). Cons Rept—Oct. 1800 w.

*8853. The Longest Non-Stopping Railway Run in the World. Charles Rous-Marten (Detailed account of the daily run of 194 miles from Paddington to Exeter on the Great Western Railway). Eng, Lond—Oct. 9. 1700 w.

8864. Contact Shoe and Brake on the New York, New Haven and Hartford Railroad (Illustration and description of the shoe and air compresser apparatus and its action). Elec Eng—Oct. 21. 600 w.

8927. The Battle of the Snow Plows. Cy Warman (Illustrated description of a snow plow contest in the Rocky Mountains, with a brief account of pilot plows and snow bucking). McClure's Mag—Nov. 2000 w.

*8931. Problems of Railway Management. Henry Clews (The causes for diminution in value of railway investments, the evils from interference of legislation, &c.). Gunton's Mag—Nov. 2400 w.

*8945. British Railway Finance (The benefit to English railway interests due to distrust of foreign securities is discussed, and the results of investing the capital in British railways are declared satisfac- Engng—Oct. 16. 700 w.

*8946. The Fatal Derailment at Preston (Statement of conditions and facts relating to the accident, with diagram of curves). Engng—Oct. 16. 700 w.

*8953. The Preston Accident (Editorial comment on Col. Yorke's report, with statement of the accident and the lesson it teaches). Eng, Lond—Oct. 16. 1700 w.

*8968. Car Heating by Steam. R. M. Dixon (The success of steam heating, description of method, rules for handling steam-heating equipment, &c.). Am Eng & R R Jour—Nov. 1200 w.

*8969. Cast-Iron vs. Steel-Tired Wheels. R. P. C. Sanderson (From a paper before the Southern and Southwestern R. R. Club. The questions of safety, weight, running qualities and rail wear are briefly considered, and also the cost). Am Eng & R R Jour—Nov. 1100 w.

8981. Narrow-Gauge Railways (A tabulation of the narrow-gauge roads of the United States, Canada and Mexico, with comment on present status of construction). Ry Age—Oct. 16. 500 w.

8989. The New Russian Locomotive Works (Photographs and description of some of the tools for the Sormovo Co. about to engage in locomotive building at Nijni Novgorod, Russia). Mach—Nov. 600 w.

*8999. Railway Speeds (Arguments emphasized and illustrated by the Preston accident, relative to the consideration traffic managers should show to the locomotive department.) Eng, Lond—Oct. 23. 2000 w.

9031. Train Accidents in the United States in September (Classified table, with editorial comment). R R Gaz—Oct. 30. 2800 w.

9057. Railway Accidents of a Year in England (Editorial comment on the report made by Francis J. S. Hopwood to the British Board of Trade). Ry Rev—Oct. 31. 900 w.

†9058. Air Cutter to Reduce Atmospheric Resistance to Railway Trains. H. W. Perry (Graphical representations of air resistance are given and remedies suggested). Ind Engng—Sept. 26. 1000 w.

*9065. From the Imperial Railway of China (Letter from C. W. Kinder, chief engineer of the Imperial Chinese Railway at Tientsin, China. Also specifications for passenger and freight engines as sent out by the locomotive superintendent for bids). Loc. Engng—Nov. 2000 w.

*9066. The Way They Take Care of Queen Victoria When She Takes a Railroad Ride. James Thompson (Interesting account of the extreme caution exercised). Loc Engng—Nov. 1200 w.

*9067. Government Railroad Track Experiments (Report of the commanding officer at the Watertown Arsenal, Mass., regarding railroad-track experiments). Loc Engng—Nov. 1200 w.

9086. Snow Plow, Grand Trunk Railway (Illustrated description of a plow made in the shops of the company, which successfully clears the tracks). Ry Mas Mech—Nov. 1000 w.

*9119. Road and Railway Communication in Bosnia and Herzegovina (Treats briefly of the excellence attained in the last twenty years in internal traffic communications). Eng, Lond—Oct. 30. 2000 w.

SCIENTIFIC MISCELLANY

Explosions of Acetylene.

NOTWITHSTANDING the assertions of interested parties that acetylene can be handled and stored without such risk as ought to obstruct its use as an illuminant, it is a matter of fact that there have been a number of explosions of acetylene. The circumstances under which these have occurred are not all of a nature to reassure doubters. *The Examiner* (Oct. 23) editorially reviews the list of explosions that have attended the recently-increased use of acetylene. It says that "the scientists . . . who have been giving a good deal of attention to acetylene" have "approved of its use, if sufficient care were taken in its employment; and, with a view to securing perfect safety, a series of rules and regulations has lately been put in force."

It was, therefore, supposed that, if these rules were observed, all danger would be removed.

"Users have had their confidence severely shaken during the past few weeks by two explosions that have been attended with fatal results. First, an apparatus employed in a café at Lyons exploded, completely wrecking the premises, and killing two persons and injuring several others. Last week yet another accident took place, when a steel receptacle containing liquid acetylene exploded at the works of M. Raoul Pictet, Rue Championnet, Paris. A part of the works was blown down, two workmen were killed, and another injured, and not a pane of glass was left in the windows of the large block of buildings. The effect of the explosion was very much like that of dynamite. The unfortunate workmen were torn to pieces, and parts of their bodies were scattered about the yard. The flesh was blackened by a substance which had penetrated into the skin, and this has enabled the experts to formulate a plausible theory as to the cause of the explosion."

Now, Raoul Pictet is famous the world over for his skill in handling, compressing, and liquefying gases. He is also a highly-trained scientist, inventor, and mechanician. When a man of this kind cannot manage acetylene without wrecking his property, it is little wonder that laymen should be timid.

At Lyons the explosion was caused by gaseous acetylene. In the Pictet works a steel receptacle of great strength, containing acetylene produced under a heavy constant pressure, burst, with the result above stated.

Contrary to the opinions of the greater number of experts, M. Pictet favors the distribution of acetylene in the liquid state, rather than the local manufacture of the gas from calcium carbid in an apparatus. "He argues that the danger arises solely from the impurities contained in the acetylene, and that these impurities must be removed by special processes before the acetylene can be liquefied without leaving a residue. He contends that another enormous advantage lies in the convenient and portable form of the acetylene receptacles, which may be conveyed any distance ready for use, and will, in course of time, be purchased at any store as required. There is, he asserts, less danger to be feared from liquid acetylene than from liquid carbonic acid, for this latter will only liquefy under pressure of sixty-five or seventy atmospheres, while acetylene requires a pressure of not more than twelve atmospheres. Nevertheless, there are two miillion carbonic acid cylinders circulating on the railways, and yet accidents from this cause are very rare. The experiments that have been made by MM. Barthelot and Vieille, the chief engineer of the French explosives department, would seem to bear out some of the arguments of Monsieur Pictet, but they still show that liquefied acetylene is more liable to explosion than the gas; and this has been repeatedly insisted upon by M. Berthelot, who has made several communications on the matter to the Académie des Sciences. They took two steel receptacles each of a capacity of about a liter, and filled one with gaseous acetylene under a pressure of ten atmospheres, and the other with liquefied acetylene with a density of .3,—that is to say, of 300 grams to the liter. The cylinders were dropped, first of all, from a height of six meters on to a steel anvil, and no explosion ensued. They were then broken by a hammer of 280 kilograms in weight, falling six meters. The compressed gaseous acetylene did not explode, but in the other cylinder an explosion took place after an almost imperceptible interval. This, it is supposed, resulted not from the pure acetylene, but from the mixture of the explosive impurities in the acetylene with the air the moment they were freed from the cylinder. The inflammation of this gas is believed to have resulted from the sparks flying from the pieces of the steel receptacle when it was broken. Then a wrought-iron bottle was taken, enclosing another containing gaseous acetylene compressed at ten atmospheres. It was fired at with a gun, and the ball penetrated the outer bottle and dented the inner one. No explosion followed the shock. A similar bottle was then filled with liquid acetylene, and a charge of 1.5 gram of fulminate of mercury was fired inside. The bottle exploded with great violence, and the effects were exactly the same as with other explosives. It therefore appears that acetylene in its liquid form is much more liable to explode than in its gaseous state, even under a pressure of ten atmospheres."

M. Pictet says that absolutely pure acetylene is obtained by his process. But either his process failed to produce pure acetylene, or his theory that pure acetylene is not explosive is not sustained. The material of which the cylinders are made is nickel steel, and they are tested to a pressure of about 3,750 pounds per square inch. The rupture of such a cylinder could be effected only by a mighty force, and its destructive power, when ruptured, would be tremendous. The fact remains, that carbonic acid requiring for its liquefaction five or six times as much pressure as acetylene is constantly handled on railways and in manufacturing establishments in large quantity, practically without serious accidents; and in precisely the same kind of cylinders as the one exploded at M. Pictet's works, and in which he proposes to distribute liquefied acetylene to consumers as a commercial illuminant. How can these apparently conflicting facts be reconciled?

It is supposed that the explosion was caused by one of the workmen in screwing in a plug, the heat thus generated igniting the liquid. The basis for this opinion is the presence of the black substance on the skin of the men injured, above alluded to. As this substance forms in quantity only upon a considerable quantity of acetylene, it is inferred that the receptacle was full, and, it being usual to insert the plug when the filling is complete, it is therefore inferred that the plugging was in progress when the explosion took place. Evidently this is a mere guess, and still more evidently there is something yet to learn about acetylene.

A New Ambulance Launch.

UNDER the direction and superintendence of Mr. Charles Thompson, a member of the Institute of Naval Architects, another steam launch for the ambulance service of the Metropolitan Asylums Board on the Thames river has been constructed. This boat, called the "Geneva Cross," will be the fourth employed in the service, the three previously built being the "Red Cross," "Maltese Cross," and "Albert Victor." From a description in *Industries and Iron* (Oct. 9) we gather the following particulars of the boat, and of the ambulance service in which it will be employed.

The peculiarities of the design are shallow draught, accommodation for recumbent patients and for visitors, a high rate of speed, and minimized vibration. The two latter features are said to have been well worked out, and much satisfaction with the boat has been expressed.

Some particulars of this marine ambulance service show its great importance. Of late years there has been an enormous amount of ambulance work of late years which the Metropolitan Asylums Board has been compelled to grapple with and to deal with expeditiously, especially that portion relating to the removal by water of infected patients suffering from small-pox. During certain periods it is probably necessary to deal only with comparatively few cases of this dreadful disease, but frequently, and indeed suddenly, it assumes gigantic proportions in the form of a violent epidemic, when it is not uncommon to be obliged to remove forty or fifty cases in one day; in fact, as many as one hundred and four cases have been conveyed to the hospital ship in one day by the ambulance steamers. The work is, however, carried out quickly and unostentatiously day by day, and its extent is probably known only by few who reside in the vast area of the metropolis under the jurisdiction of the board. Seeing that the ambulance work of the board has now reached Tottenham, Penge, and goes as far as West Ham, it became imperative that a launch suitable for the conveyance of infected patients by water from the shallow reaches of the Upper Thames should be provided. There are also three wharves, the property of the board, from which infected patients are embarked and disembarked after being cured at the hospital ships,—*viz.*, the West Wharf, at Fulham; the North Wharf, at Blackwall; and the South Wharf, at Rotherhithe, where isolation shelters are also provided for the reception, examination, and accommodation of doubtful cases of smallpox. Such patients are detained in these shelters until the disease from which they are suffering is sufficiently developed and thoroughly diagnosed, and, in the event of it proving to be small-pox, they are sent forthwith to the hospital ships for treatment, but, if otherwise, they are dealt with in a different manner. The rooms occupied by such patients are at once thoroughly disinfected and prepared for the reception of other patients.

"In 1893 the steamers above-named conveyed no less than 10,652 passengers to and from these wharves to the hospital ships at Long Reach. Of this number 2,364 were infected patients; 2,053 were recovered patients brought back to London; and 6,235 were visitors, staff, workmen, and others. The vessels were under steam for 698 days, travelling 28,341 miles, and carrying, in addition to the passengers, about 50 tons of stores of various kinds. In 1894 the number of passengers conveyed to and from the ships was 7,614, of which 1,101 were infected patients taken to the ships, 1,009 were recovered patients returned to London; the remainder, 5,504, being visitors, staff, workmen, etc. The vessels were under steam for 880 days, and carried, besides passengers, stores weighing nearly 100 tons. This large amount of beneficent work has been carried out in the most economical and satisfactory manner—without one single mishap—by the board's superintendent, who is also a retired naval engineer officer, and has so arranged the details appertaining to the work as to render it necessary to employ, as a rule, only two crews for the whole of the vessels, and has found that to be sufficient to meet the exigencies and requirements of the river ambulance service.

"These are facts and figures which very few people are cognizant of, and show most clearly the admirable work performed by the board. They also demonstrate that measures are adopted by them by means of which the health—indeed, the very lives of the population of this great city—are protected."

Iridescent Glass.

ANY one who has visited the Metropolitan Museum of Art in Central park will doubtless remember the collection of ancient glassware there exhibited. Some have doubtless supposed that the beautiful iridescence of the glass in these exhibits was produced artificially. It is a fact that iridescent glass can be made artificially by treating the glass with chemicals and by other means, but it is also a fact that glass long exposed to the action of atmospheric influences becomes iridescent, and hence the finds of ancient glass ware in buried cities, etc., are nearly always iridescent. Mr. Charles E. Benham, in *Engineering* (London, Oct. 9), explains the nature of iridescence, and discourses pleasantly and instructively upon this and other signs of antiquity in glass. Iridescence results from what, in the science of optics, is technically called interference. The phenomenon of interference is explained in all text-books of optics, and is easily understood. It is a result of refraction and reflection acting simultaneously, the effect being to suppress some of the ether waves in the total of white light, thus producing colored light according to the waves so suppressed. The presence of a thin transparent film produces this effect, whether the film be itself glass or some other material.

The changes which glass undergoes under the action of the elements ultimately results in its disintegration, although it is popularly thought to be, and is, one of the most indestructible of substances. When glass is buried, a thin transparent film forms upon its surface. Light is reflected from both the outer and inner surface of this film, and is also refracted in passing through it, the combined result being the suppression of some of the ether waves and the partial decomposition of the white light. The film may not be always of the same composition, but its effect in producing interference depends, not upon its chemical composition, but upon its thickness.

Iridescent glass is one of the most beautiful objects known to man. It has, therefore, been attempted, and successfully, to produce the iridescence artificially. As soap-bubbles are iridescent, so glass blown in very thin bulbs is iridescent; but, of course, this has no value on account of its fragility. Mr. Benham says that "iridescent glass which will bear handling may be made in several ways. We may have a thin film of any transparent substance on its surface, or its own substance may be so laminated that the upper layers produce interference. The external film of some foreign substance comes in many different ways. It is not uncommon to see a glass water-bottle that has stood disused for a long while tinged with red and purple iridescence from a thin film of salts on its inner surface, deposited probably by the water which has been inside it, and so tightly will this film cling that it is not always easy to get rid of it. But, when glass has lain exposed to the elements, and especially in damp soil, a film, composed, according to Péligot, of silica and earthy silicates, gradually forms over it and gives a much more brilliant iridescence, accompanied with a silvery glistening. This film does not appear always to be derived from the glass, for, when it is scraped off, which is accomplished with difficulty, it is often found that the surface beneath it is still quite smooth and polished. The deposit is probably derived from the rain, which is impregnated with a certain quantity of silica derived from the soil over which it runs. But, when the exposure to the elements has continued still longer, the glass itself begins to undergo change. Its surface, when viewed under the microscope, after the removal of the external film, is dotted all over with tiny excrescences, like little bubbles of glass. Acids which cause the external film to flake off easily, by dissolving the silicates, do not affect the glass excrescences below, which glow with rich deep colors, generally much darker than those of the glistening external coating. With greater age the uneven character of the glass surface is much more marked, and a microscopic examination of the various stages of change suggests a rough and ready method of computing the antiquity of the glass, though, of course, modifying influences may prevent exact accuracy being arrived at in this way.

"The greatest sign of extreme antiquity is probably the lamination of the glass, which may often be seen to be split into layers parallel with the surface, like mica or selenite, and in some cases ancient glass vases, when unearthed, have entirely split up into mere flakes. It is easy to see how the lamination causes iridescence on the principle of interference by thin films, and the preceding stage of minute hemispherical bubbles would, of course, produce the same effect, though Mr. Wallace-Dunlop, in his 'Glass in the Old World,' says that the light is 'cylindrically de-polarized as it were,' whatever that may mean.

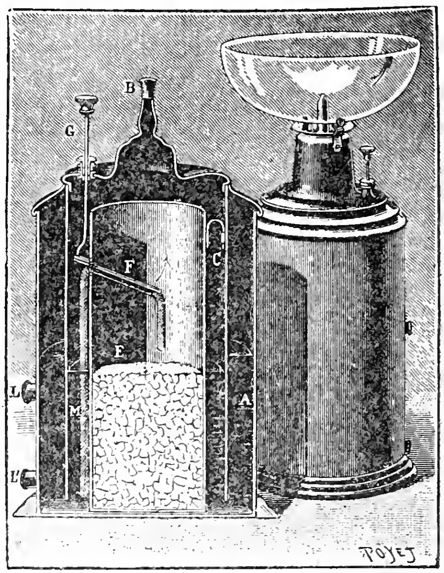
"It appears that white glass is less easily acted upon than the colored varieties, and, according to a writer in the 'Encyclopædia Britannica,' alkaline varieties are specially affected. Sir David Brewster expresses himself very poetically when he says of this 'disintegrated' glass that 'there is perhaps no material body that ceases to exist with so much grace and beauty when it surrenders itself to time, and not to disease.' As to the causes of the changes which glass undergoes in course of time, every authority adopts the supposition that there is a chemical action. Rood says that some of the alkali appears to be removed by the rain. Numerous writers refer to the apparent influence of ammonia, as evidenced by the alleged special tendency of glass in stable windows to become iridescent."

Mr. Benham evidently does not think the chemical theory accounts well for all the facts. He rather inclines to the belief that iridescence of ancient glass results from a long series of changes in temperature; but this theory will be harder for most people to accept than the chemical theory. Passing from theory to what has been done in the manufacture of iridescent glass, it is said that thin films of silicate of soda deposited on glass produce iridescence, but fail to gain the gorgeous effects of the ancient specimens. Some approximation to these effects has been obtained by M. Brame by the use of hydrofluoric acid and fluorid of calcium. M. Meunier found that fumes from volcanic ashes would render glass iridescent. The patented process discovered by M. Frémy and M. Clémandot produces beautiful effects, but does not well imitate the antique glass. The effects are gained in this process by the combined action of heat, pressure, and weak acids.

A Simple Acetylene Lamp.

THE illustration of this new lamp is reduced from *La Nature*, from which also is derived the following condensed description. The lamp is, presumably, of French devising. It is so easy to construct that almost any worker in sheet metals could make one, but it ought not to be made of copper or brass.

An external receptacle, A, is provided at one side with two apertures closed by screw plugs, L and L′. Within this there is a cylinder suspended by its upper part and not reaching the bottom of the receptacle, A. In the center there is another cylinder, D, closed at the bottom and open at the top. The cover of the apparatus is provided at B with a fishtail burner, and at G with an aperture to permit of the passage of a vertical rod. The carbid of calcium is placed in E. At F there is a nearly horizontal rod that supports a wick whose



ACETYLENE LAMP.

lower extremity is immersed at M in the water that has been introduced into the external cylinder. The rod, G, permits of displacing the rod, F, through simple pressure.

When the lamp is filled, it suffices to raise the rod, G, when the water absorbed by the wick will ascend through capillarity and fall drop by drop upon the carbid. The acetylene gas immediately produced is lighted at the burner, B. In order to arrest the operation of the lamp, it suffices to lower the rod, G, when the rod, F, will immediately rise, and the water will no longer fall.

In order to prepare the lamp, it is necessary first to remove all the internal parts, screw up the plugs, L and L′, and fill with water to a level slightly above the first aperture when all the parts are in place.

The central cylinder is afterward charged with carbid up to a certain height, taking care that the wick shall not be in too close proximity. All the internal parts are then replaced, and the cover is put on. The regulating rod is lowered, and the lamp is ready to operate.

Before setting the lamp in operation, it is necessary to make sure that the plugs are well screwed in, and that the rod, F, is in condition to move freely. The intention is to consume the gas as fast as it generates,—not to accumulate a store of gas for future use.

Purification of Acetylene.

In a lecture given at Liege by the famous Professor Raoul Pictet, of Geneva, he stated a method whereby the impurities contained in commercial acetylene may be safely and entirely removed. When pure, the combustion of this gas generates the most powerful artificial light known to man. He exhibited candelabra, each having nine burners, and consuming nine and one-half feet of pure acetylene gas per hour, with which, in comparison, the electric light seemed a pale illumination.

In its impure state this gas is dangerous. Its impurities attack the metals, especially copper; and the salts thus formed are transformed into explosive acetylene of copper. Acetylene itself, an endothermic substance, has a tendency to explode, if its impurities permit of molecular change. Professor Pictet, however, here takes advantage of the law as to critical temperatures, by virtue of which all chemical reaction, even the most active, may be arrested by a sufficient degree of cold; and he showed that sodium—which burns spontaneously on the simple contact of water—is uninfluenced by hydrochloric acid when cooled down to about 60 deg. below zero Cent., although it is attacked when the temperature is raised to 50 deg. below zero Cent. In the same manner acetylene is uninfluenced by sulphuric acid at 50 deg. below zero Cent., while all its impurities are arrested by that acid at the same temperature; and this physico-chemical filter thoroughly refines acetylene, while rendering it liquid and inoffensive. In this state the gas is stored in nickelized steel cylinders, and a small gasometer permits of its expansion and immediate utilization, the illuminating power being fifteen, twenty, thirty, and even forty times that of ordinary lighting gas.

Damage by Lightning.

The director of the statistical office in Berlin has stated, says *Public Opinion*, that damage to property and loss of life by lightning are unmistakably increasing. It has been shown that in Bavaria the fires due to lightning increased from a yearly average of thirty-two in 1833 to 1843 to one hundred and thirty-two in 1880 to 1882, while the number of persons struck by lightning and of those killed rose from one hundred and thirty-four and seventy-three respectively in 1855 to one hundred and eighty-six and one hundred and sixty-one in 1885. The causes assigned for the increase are the employment of electricity in various industries, the continual change of form of the earth's surface by deforestation, drainage, etc., and the impurities introduced into the atmosphere by the growing consumption of coal.

This category of causes, the potency of which is problematical, leaves out of account a cause whose influence cannot be doubted,—namely, the increasing density of the earth's population. Considering the earth as a target for a fixed annual number of lightning strokes, the settling of unoccupied lands and the multiplication of structures distributed over the surface must increase the number of casualties. If on every square yard in any region of the earth's surface there stood a man, every lightning stroke in that region would result in injury or death to a human being.

Multiplication of buildings must have the same effect upon fires caused by lightning; and it would seem that the number of fires thus caused ought to increase very nearly as the area covered by buildings not fire-proof.

Aluminum Cooking Utensils.

THE present status of aluminum as a material for cooking utensils was stated in a paper read before the recent congress of applied chemistry by Mr. Boroma.

"The utility of an aluminum dish, in respect to its fitness for culinary vessels, depends on the purity of the metal. A pure aluminum dish is almost, if not quite, as resistant to solvent effects of ordinary foods as any common metal. The impurities which do the most harm are sodium and carbon. When the aluminum contains carbon, an electric current is at once set up when a suitable liquid is applied. In such cases, after water, especially if it be saline, has stood in the dish for one or two weeks, the surface will be found dotted with brilliant rings, and, on scraping off the aluminum, the particle of carbon will be disclosed. If a strong solution of salt be used, the action may be sufficient to cause a perforation of the metal. The aluminum of commerce, unfortunately, is not very pure, and it is for this reason that so many aluminum dishes have shown a rapid deterioration. The French troops in Madagascar have been supplied with fifteen thousand sets of aluminum dishes, and, when a soldier has to carry his kitchen with him, the importance of lightness is not to be despised. But, even granting that in cooking in aluminum dishes a small amount of alumina is introduced into the food, it has not been shown that it exercises the least harmful action on the digestion. The experience of two men may be cited who lived for a year on food prepared exclusively in aluminum dishes without the slightest impairment of their health."

Possibilities of Beet Sugar in the United States.

MR. HERBERT MYRICK, of Springfield, Mass., has written a letter to *Bradstreet's* on the subject of beet-sugar production, in which he expresses belief in the possibility that the United States might profitably produce all the sugar it consumes. The desirability of such a consummation will be admitted in view of the fact that more than $100,000,000 are annually paid in this country for imported sugar. Yet, there is already a large amount of domestic beet-sugar produced. California leads in the industry, but Utah, New Mexico, Nebraska, and Wisconsin are coming into line, and the experiment stations of other States have proved, and are proving, that the profitable cultivation of sugar beets may be instituted in many other localities. About 300,000 tons of domestic beet sugar are now produced, while nearly 2,000,000 tons are imported.

The beet crop is said to be attended with no waste whatever. After the juice has been expressed, the remaining parts of the plant, including the tops, are stated to be nutritious food for cattle, and to favor a yield of milk from cows. As sugar contains nothing but carbon, oxygen, and hydrogen, the growth of beets ought not to impoverish land when the utilization of the roots and tops by feeding cattle upon the land producing the beets is carried out.

The following points are named as important to investors in the consideration of projected beet-sugar enterprises.

First. The factory must be assured of a certain supply of beets of good quality. Even if pledges of an abundance of beets are forthcoming, they are of little value, unless it has been determined by actual experiment upon the lands in question that they will produce beets of proper quality as well as quantity. At least two or three years' tests are usually necessary to determine this beyond a doubt. Fortunately, such tests have been made already in a large number of places. Too much stress cannot be laid on getting plenty of rich beets.

Second. The beets should be grown as near the factory as possible; a haul of fifty to a hundred miles absorbs much of the profit on the crop. There should be sufficient beet land available within reasonable distance to furnish the desired quantity of beets when only one-third of such land is sown to beets, thus permitting a wise rotation of crops. Beets can be grown year after year on the same land, but it is not good agricultural practice.

Third. A successful factory requires an

almost unlimited supply of pure water, good and cheap lime, also fuel, while facilities for getting the sugar to market are important.

Fourth. The best talent and the best machinery are the cheapest in starting or operating a sugar factory.

These and other points properly looked after by experts, and over-capitalization avoided, a beet-sugar factory, with good business management, under appropriate national and State encouragement during the first few years, will prove a safe and profitable investment.

Paraguayan Timber Woods.

CONSUL SAMUEL W. THOMÉ sends from Asuncion an account of the woods obtainable in Paraguay, his communication being published in *Consular Reports* for October.

The export of cedar wood from Cuba to Europe has ceased, partly on account of the Cuban rebellion, and partly because the supply of cedar has been nearly exhausted. According to Mr. Thomé, Paraguayan cedar is likely to take its place. He does not rank it as fully equal to the Cuban cedar, but says it is, nevertheless, of good quality, both in color and texture.

It appears that Paraguay is a habitat of a considerable variety of trees whose wood possesses valuable qualities. Some of those most highly spoken of are petereby-negro, black palm, espanillo, curupay, tatana, guayabi, palo santo, quebracho negro, quebracho blanco, lapacho, bitter iviviraro, iviviraro-mi, incienso, and palo blanco. These are selected from a list of some twenty named by Mr. Thomé because of their valuable properties.

The petereby-negro is one of the best woods produced in the world. It is an excellent mast timber, and can be obtained in pieces of great length. It takes a fine polish, makes handsome furniture, and is very durable, light, and odoriferous. It resembles American walnut in color, but can be obtained with a wavy grain.

The black palm is also spoken of as a first-class wood. It is, however, very hard. It makes excellent veneers, is susceptible of a high polish, and under water or under ground is said to be practically everlasting.

The wood of the espanillo has qualities so lasting that small sticks of two to three inches in diameter remain sound under ground for forty or fifty years.

Curupay is an excellent pile timber for docks and bridges. It is also in demand for sleepers, and its bark is used for tanning. Tatana is a hard, handsome, yellow wood, also good for sleepers, and used by ship-builders for shoulder and stern-posts. It appears to be one of the best woods for many purposes. Guayabi is a tough, flexible, elastic wood, used for bullock yokes, axe-handles, etc., and said to be superior to American hickory.

Palo santo is a beautiful wood for fancy turning. Quebracho negro is ranked as "the king of hard wood." "*Quebracho*" signifies "axe-breaker." It is used for tanning, and its durability in earth or water is exceeded by no other timber. Quebracho blanco has the properties of quebracho negro, except that it is of no use for tanning.

Lapacho is a greenish-yellow wood of great strength, and does not crack or split easily. It is largely used for ship-building and railway purposes, but does not last well in damp soil. A curled variety is spoken of as making beautiful furniture. It is a highly inflammable wood.

The bitter iviviraro resembles oak in appearance, does not crack, is always sound in the heart, and is a valuable timber. The natives make cart-wheels of it, which they use without tires. It is said to be easily worked and excellently adapted to ship-building carpentry and carriage-building. Iviviraro-mi is a highly-prized wood, used for engraving blocks. Incienso is used for parquet flooring, on account of its odor and durability. Palo blanco is a tall tree, furnishing a wood stated to be practically everlasting against wind and weather. It is easily worked. Borers never attack it, and it is not subject to dry rot.

THE production of coal in India is steadily increasing. In 1885 there were mined 1,295,000 tons, while last year the figures were increased to 3,167,000 tons. The

Bengal collieries are responsible for about two and a half millions of the total. Much attention has also been paid of late years to the discovery of mineral oil wells, but the success attained has not been encouraging so far, though some 36,000 gallons of oil were obtained from the Digboi field in 1895. The boring at Sukkur has failed to reach an oil bed, though it has been carried to a depth of 1,500 feet, and is to be sunk 200 feet further before being abandoned.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

8687. Cost of European Geological Surveys. E. A. Schneider (Part first considers the work as carried on in Russia and Germany). Eng and Min Jour—Oct. 10. Serial. 1st part. 2000 w.

8719. Address by the President of the British Association for the Advancement of Science (J. J. Thomson's address at the Liverpool meeting beginning Sept. 16. A general review of progress during the year in mathematics and physics). Sci Am Sup—Oct. 17. 5800 w.

*8767. The Phonograph (Illustrated description of the most modern phonograph and its possible future). Engng—Oct. 9. 2500 w.

*8768. Iridescent Glass. Charles E. Benham (Cause of iridescence. How produced by atmospheric influences, and artificial imitations of these effects). Engng —Oct. 9. 2000 w.

†8830. Valuable Woods of Paraguay (Twenty different woods are named and their characteristics and industrial uses specified). Cons Rept—Oct. 1500 w.

†8831. Transportation of Butter in Refrigerator Ships (Danish Government tests of artificial refrigeration and its effects upon butter shipped on vessels from Copenhagen to Leith). Cons Rept—Oct. 2000 w.

†8832. Refrigerated Meat Trade of Australasia (Statistics and other information showing the extent of the trade and its effects upon the world's market for food supplies). Cons Rept—Oct. 2000 w.

†8833. Refrigerated Meat Industry of Victoria (The refrigerating methods employed, extent of the business and other particulars). Cons Rept—Oct. 2400 w.

†8834. Beet Sugar Industry of France (The present state of the industry, with tabulated statistics. Possibilities of beet culture in the United States). Cons Rept—Oct. 2500 w.

*8861. The Technical Education of Artisans (Address before the students of the Liverpool School of Science, Technology and Art, by W. H. Preece. The awakening in England to the value of technical education, the progress already made and necessities and duties of the future are the topics treated). Eng, Lond—Oct. 9. 1800 w.

8886. The Beet Sugar Industry and Its Prospects. Herbert Myrick (The present prosperous condition of the industry, its possible large extension in the United States and essentials to its success are pointed out). Bradstreet's—Oct. 24. 2000 w.

*9000. Acetyline as an Explosive (A timely account of explosions and accidents with acetyline, which emphasizes the care needed in handling this material). Eng, Lond—Oct. 23. 1800 w.

†9014. The Animal as a Machine. Robert H. Thurston (The length and breadth of the most attractive, yet most tantalizing problem yet presented to man and yet wholly unsolved is here set forth. The conclusion is that muscular energy, whatever it may be, is not thermodynamic). N Am Rev—Nov. 4500 w.

9074. Wealth Based Upon Elastic Gum. Hawthorne Hill (The rubber industry is described in a general popular style, giving many points of commercial interest). Sci Am Sup—Nov. 7. 2400 w.

†9084. The Elective System in Engineering Colleges. M. E. Wadsworth (Presents particulars and points out the conditions under which this system might with advantage be introduced more generally). Am Geol—Nov. 2800 w.

*9099. The Origin of Waves of Light. W. Wedding (The frequency and rate of transmission of ether waves which manifest themselves upon the retina as light of different colors. Differences between solar and artificial illumination. Abstract of paper read before the German Assn. of Gas and Water Engs.) Jour Gas Lgt—Oct. 27. 1500 w.

9105. The Chemical Industry and Technical Teaching (Argument favoring the introduction of industrial chemistry among the branches taught in high schools. The experiences of Germany in the beneficial effect of such teaching is cited). Eng and Min Jour—Nov. 7. 1000 w.

†9110. Edwin Marcus Chaffee as a Rubber Inventor (Biographical account, with description of inventions). Ind Rub Wld —Nov. 10. 2000 w.

†9111. Pure Rubber the Weak Point in Bicycle Tires. Gustav Heinsohn (An explanation of the cause of deterioration and the care needed). Ind Rub Wld—Nov. 10. 1500 w.

*9149. Considerations on Painting. Russell Sturgis (Review of book by John La Farge. Lectures given in the year 1893 at the Metropolitan Museum of New York. Many illustrations and the highest praise). Arch Rec—Oct.-Dec. 4000 w.

BOOKS OF THE MONTH

Descriptive Circulars containing full information relative to books herein named may be obtained of the publishers.

Goodwin, H. B. Azimuth Tables for the Higher Declinations (Limits of Declination 24° to 30°, both inclusive) Between the Parallels of Latitude 0° and 60°: With Examples of the Use of the Tables in English and French. Longmans, Green & Co., New York. 1896. Cloth, $2.50.

Lawler, Ja. J. American Sanitary Plumbing. Excelsior Publishing House (T. Carey & Co.). New York. 1896. Cloth, $2.

Bell, G. J. A Practical Treatise on Segmental and Elliptical Oblique or Skew Arches. Spon & Chamberlain, New York. 1896. Cloth, $8.40.

Glover, J. Formulæ for Railroad Crossings and Switches. Spon & Chamberlain, New York. 1896. Cloth, $1.

Merriman, Mansfield, and Woodward, Robert. Higher Mathematics. A Text-Book for Classical Schools and Engineering Colleges. Importers, John Wiley & Sons, New York. 1896. Cloth, $5.

Dana, C. A. Proudhon and His "Bank of the People." B. R. Tucker, New York. 1896. Paper, 10c.; leatherette, 25c.

English, Vincent J. Navigation for Yachtsmen. Importers, Charles Scribner's Sons, New York. 1896. Cloth, $7.20.

Kidder, F. E., C. E., Ph. D. Building and Superintendence, Part I. Masons' Work. William T. Comstock, New York. 1896. Cloth. $4.

Birkmire, William H. The Planning and Construction of American Theaters. William T. Comstock. New York. 1896. Cloth. $3.

Du Bois, H. The Magnetic Circuit in Theory and Practice. Translated by Dr. Atkinson. Longmans, Green & Co. New York. 1896. Cloth. $4.

Ferguson, L. A. Electrical Engineering in Modern Central Stations. University of Wisconsin, Madison, Wis. 1896. Paper. 35 cents.

Metcalf, W. Steel: A Manual for Steel Users. J. Wiley and Sons. New York. 1896. Cloth. $2.

Edison, T. F., and Westinghouse, C. J. The Mechanics' Complete Library of Modern Rules, Facts, Processes, etc. Revised Edition. Laird Lee. Chicago. 1896. Cloth. $1.

Graham, J. An Elementary Treatise on the Calculus for Engineering Students. Spon & Chamberlain. New York. 1896. Cloth. $2.

Judson, Isabella Field. Cyrus W. Field; His Life and Work. Harpers. N. Y. 1896. Cloth. $2.

Rix, E. A. and Chodzko, A. E. A Practical Treatise on Compressed Air and Pneumatic Machinery. G. Webb Alexander. San Francisco. 1896. Leather, pocket-book style. $4.

Bulfinch, Ellen Susan. The Life and Letters of Charles Bulfinch, Architect. With Introduction by C. A. Cummings. Houghton, Mifflin & Co. Boston. 1896. Cloth. $5.

Waring, George E. Modern Methods of Sewage Disposal for Towns, Public Institutions, and Isolated Houses; 2nd revised edition. D. Van Nostrand Co. New York. 1896. Cloth. $2.

Sternberg, G. M., M. D. A Text-Book of Bacteriology. W. Wood & Co. New York. 1896. Cloth. $5.50. Sheep. $6.50.

Barter, S. Manual Instruction: Drawing. The Macmillan Co. New York. 1896. Cloth. 80 cents.

Maycock, W. Perren. Electric Lighting and Power Distribution. The Macmillan Co. New York. 1896. Cloth. $1.75.

BOOKS RECEIVED.

The Street Railway Publishing Co., New York. American Street Railway Investments. Annual Supplement to the Street Railway Journal. 1896. Cloth, $3.

Mattice, Asa M., late of the engineer corps U. S. N. Queer Doings in the Navy. A letter from an ex-naval officer to Hon. Francis Wilson.

Benzenberg, C. H. Annual Report of the Board of Public Works of Milwaukee, for the year ending December 31, 1895.

Crehore, Albert Cushing, and Squier, George Queen. Experimental Determination of the Motion of Projectiles Inside the Bore of a Gun, with the Polarizing Photo-Chronograph. Reprinted from the Journal of the United States Artillery, Vol. V., No. 3.

Shedd, J. Herbert. Annual Report of the City Engineer of the City of Providence for 1895.

Waring, George E., Jr. A Report on the Final Disposition of the Wastes of New York by the Department of Street Cleaning. 1896.

Windsor, H. Editor. Street Railway Law. A Digest of Important Decisions Covering the More Important Class of Cases Which Occur in the Management of Street Railways. Windsor & Kenfield Publishing Co. Chicago. 1896. Cloth, $2.

Hertz, Heinrich. Miscellaneous Papers. With an Introduction by Prof. Phillip Lenard. Translated by D. E. Jones, B. Sc. and G. A. Schott,

B. A., B. Sc. The Macmillan Co., 66 Fifth Avenue, New York. 1896. Cloth, $3.25.

U. S. Consular Reports, June, 1896. Commerce, Manufactures, etc.

Gerdtzen, G. Adolph. (Bulletin of the University of Wisconsin). The Problem of Economical Heat, Light, and Power Supply for Building Blocks, School Houses, Dwellings, etc. Madison, Wis. Published by the University. 1896. Paper, 45 cents.

Tenth Annual Report of the Commissioner of Labor. 1894. Strikes and Lockouts. Vol. 1. Washington. Government Printing Office. 1896.

Hale, R. S. Circular No. 5 of the Steam Users' Association. Report on European Practice. Steam Users' Association, Boston. 1896.

Twentieth Year-Book of the New York State Reformatory ; Year ending September 30, 1895. With Illustrations and Anthropomorphic Tables. New York State Reformatory, Elmira, N. Y. 1896. Paper.

Brough, Bennett H., Editor. Journal of The Iron and Steel Institute. Vol. XLIX. E. & F. N. Spon, London-New York. 1896. Cloth.

Exports Declared for the United States Returns from Consular Districts for Quarter ending March 31, 1896. Government Printing Office, Washington, D. C. Paper.

Consular Reports, Aug., 1896. Commerce, Manufactures, etc. Government Printing Office, Washington, D. C. Paper.

Mayor's Message, City Controller's Report, and Reports of Departments of the City of Williamsport, Pa., for the Year 1895. Also Certified Ordinances. Gazette and Bulletin Printing House, Williamsport, Pa. 1896. Paper.

Ninth Annual Report of the Board of Public Works, City of Duluth, For the Year Ending February 29, 1896. Paper.

Keating, E. H., City Engineer. Annual Report of the City Engineer of Toronto for 1895. Caswell & Co., Toronto, 1896. Paper.

Transactions of the American Institute of Mining Engineers. Vol. XXV. February, 1895, to October, 1895, inclusive. American Institute of Mining Engineers, New York.

Twenty-First Annual Report of the Board of Commissioners, Department of Parks, Boston, Year Ending January 31, 1896.

Wilkinson, H. D. Submarine Cable Laying and Repairing. The D. Van Nostrand Company. New York, 1896. Cloth. $5.

Commercial Relations of the United States with Foreign Countries, During the Years 1894 and 1895. Vol. II. Government Printing Office, Washington, D. C. 1896.

Kidder, F. E. Building Construction and Superintendence. Part I,—Mason's Work. William T. Comstock. New York. 1896. Cloth. $4.

Sachs, Edwin O., and Woodrow, Ernest A. E. Modern Opera Houses and Theatres. Vol. I. Royal Quarto, 100 plates, and 100 diagrams. B. T. Batsford, 94 High Holborn Street, London. 1896. Buckram, gilt. £15 15s.

Bowers, George. Twenty-Third Annual Report of the Lowell Water Board for 1895. Lowell Water Board, Lowell, Mass. Cloth.

The Cornell University Register, December, 1895. Published by the University, Ithaca, N. Y. Paper.

Balch, Lewis. A Manual for Boards of Health and Health Officers. Banks & Bros. New York. 1896. Cloth. $1.50.

Clerk, Dugald. The Gas and Oil Engine. J. Wiley & Sons, New York. 1896. Cloth. $4.

Knight, J. H. Notes on Motor Carriages, with Hints for Purchasers and Users. Imported by Charles Scribner's Sons. 1896 Cloth. $1.

Appleby, C. J. Illustrated Handbook of Machinery. Spon & Chamberlain. New York. 1896. Cloth. $1.50.

Denton, E. Barley. Sewage Purification Brought up to Date. Spon & Chamberlain. New York. 1896. Cloth. $3.

Newman, J. Metallic Structures,—Corrosion and Fouling, and Their Prevention. Spon & Chamberlain. New York. 1896. Cloth. $3.50.

Schlich, W. Manual of Forestry. Imported by Charles Scribner's Sons, New York. 1896. Five Volumes : Vol. 1, $3 ; Vol. 2, $4.20 ; Vol. 3, $5 ; Vol. 4, $5 ; Vol. 5, $6.

Gerhard, William Paul. Theater Fires and Panics ; their Causes and Prevention. John Wiley and Sons, New York. 1896. Cloth. $1.50.

Elliott, W. H. Block and Interlocking Signals. Locomotive Engineering, New York. 1896. Flexible Morocco. $3.

Sturgis, Russell. European Architecture : A Historical Study. The Macmillan Company, New York. 1896. Stamped Binding. $4.

Nichols, Edward L., and Franklin, William S. The Elements of Physics : A College Text-Book. In three volumes. Vol. II. Electricity and Magnetism. The Macmillan Company, New York. 1896. Cloth. $1.50.

Jackson, Dugald C., and Jackson, John Price. Alternating Currents and Alternating Current Machinery. The Macmillan Company, New York. 1896. Vol. II. Cloth. $3.50.

Miller, M. K. Annual Report of the Superintendent of Streets to the Board of Public Works of the City of Oakland, Cal., for the Year Ending June 30, 1896. Paper.

Circular No. 5 of the Steam Users' Association. Report of Mr. R. S. Hale on European Boiler Practices. Steam Users' Association, Boston. 1896. Paper.

Day, William C. The Stone Industry in 1895. Government Printing Office, Washington, D. C., 1896. Paper.

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THE PARAMOUNT CONTROL OF THE COMMERCE OF THE WORLD.

By Edward Atkinson.

I AM asked to write an introductory chapter for a "Prosperity Number" of THE ENGINEERING MAGAZINE. That opens a broad question. What is prosperity? What is necessary to its attainment in the aspect of the conditions which exist at the present writing?

We are dealing with the material conditions on which our life on this planet rests. Existence depends wholly upon food, fuel, clothing, and shelter. All that any one, rich or poor, can get, in a material sense, out of life is his board and clothing. The whole process of the production and distribution of what is called wealth is conducted for the single purpose of providing the materials of existence for consumption. Consumption and reproduction are the end and aim of all trade and industry. Provision must be made every day for what every man must have, be he rich or be he poor. In these modern days it has become the admitted duty of society to provide the necessary food, fuel, shelter, and clothing for paupers who have become incapable of providing for themselves. Food, fuel, shelter, and clothing are all that, in a material sense, the richest man can provide for himself.

What we now call society in this country consists of about seventy-three million human beings. Each one must be supplied every day with two-and-one-half to five pounds of food-material, with fuel wherewith to cook it, and with a certain amount of textile fabrics or furs, and with some boards to put over his head.

The world, as a whole, is always within about one year of starvation, within two or three years of becoming naked, and within a very few years of becoming houseless. In this country nearly two million human beings are added every year to our population. That number would soon crowd existing dwellings to death, unless in each year about a half-million men were occupied in adding to the number of dwellings already existing.

We call ourselves very rich. We gloat over the billions of dollars' worth of property disclosed by the figures of the census. In 1890 the computation reached the huge sum of over sixty-five billions of dollars. Only think of it! How rich we are! But what does it all come to? About one-third of this valuation is the estimated value of the land on which capital has been placed. Land is our endowment, not our creation. If we deduct a reasonable sum for land valuation, what is left is the capital of the community,—about forty-five billion dollars. This is an estimate in dollars of what we have saved and put to purposes of enjoyment or future use in more than a century of existence as a nation. Again, this is a stupendous sum. What does it amount to?* If the value in money of all that we consumed—food, fuel, shelter, and clothing—in the census year, figured at retail prices, was equal to fifty cents a day per person, then the product of the census year reached a valuation in terms of money, in round figures, of eleven and one-half billion dollars.

That sum was equal to twenty-five per cent. of our whole capital. It was probably more. If we add what is consumed where it is produced, but not sold, and that part of the product which is taken by taxation, then we may reach sixty cents' worth a day,—denoting an annual product worth, in terms of money, two hundred and nineteen dollars a year to each person, and a total valuation in the census year, in round figures, of close upon fourteen billion dollars. We have saved, in all, a little over seven hundred dollars' worth of property, on the average, to each person, and we must consume, in order to

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* CENSUS VALUATION, 1890.

Real estate and improvements	$39,544,544,333
Mines, quarries, and product	1,291,291,579
	$40,835,835,912
Deduct one-half for land	20,417,917,956
	$20,417,917,956
Railroads and equipment	8,685,407,323
Telegraph, telephone, shipping, and canals	701,755,712
Machinery, mills, and product on hand	3,058,593,441
Gold and silver coin and bullion	1,158,774,948
Live stock on farms, implements, and machinery	2,703,015,040
Miscellaneous	7,893,708,821
	$44,619 173,241

live, nearly two hundred dollars' worth of product,—probably more. In other words, in a little over a century of existence as a nation, and in less than a century of union under a constitution, we have succeeded in saving products of human labor in the form of public buildings, warehouses, workshops, factories, railways, vessels, dwellings, tools, machinery, and goods and wares on the way from the producer to the actual consumer, to the amount of a little over seven hundred dollars' worth per head. We consume every year nearly a third as much as this measure of all our savings.

If any reader thinks that the consumption can be measured at less than what fifty cents a day will buy at retail prices, let him try it. On that low estimate such are the facts. I am inclined to esteem the valuation of our capital too large, and the valuation of our consumption too small.

We can never beat old time more than two or three years—or, at the utmost, four years—in the richest nation, because there is nothing constant but change. There is no such thing as fixed capital. The inventor and the scientist are the great destroyers of wealth, substituting for the old mechanism the new devices by which production is increased, labor is diminished, prices are reduced, and wages are augmented. All of permanent influence that we can save is experience and skill, which, being developed in practice, assure a reduction in the necessary hours of labor, a relief from the intensity of toil, and, as time goes on, a sure removal of noxious and unwholesome conditions of work. Yet, narrow and strenuous as these conditions are, in the world there is always enough. Where is it? In this country there is always more than enough for the support of life through each period of four seasons making a year. The world has become a neighborhood. The food which each reader ate to day, the fibres in which he was clothed, and the materials with which he was sheltered, had been brought, on the average, a thousand miles or more, from the place of their origin. Yet he had only to tap a button in the wall of his house to bring his whole supply to his table or to his service at the very time and place he needed it. Such are our material wants, and such is the approximate measure of our supply.

Dealing with this question under these conditions, it becomes evident that the prime factor on which the prosperity or general welfare of the whole community rests is mental, and not manual. If there is confusion of mind in the use of words, there will be confusion in the laws. If there is confusion in the laws, there will be obstruction to mutual service. If there is confusion of mind in the conduct of affairs, there will be confusion in all the material processes of distribution; there will be a glut here, want and starvation there. Men may suffer want close to the abundance by which their wants could be met to their own benefit and to that of whoever should supply them. Idle men may crowd the cities while the materials of existence—food, fuel, clothing, and shelter—are lying at a distance of only one or two days' work. Such have been the bad conditions which have ensued since the silver panic of 1893, caused by mental aberration, and not by lack of a supply adequate to all material wants. A few years ago the price of a day's wages of a good mechanic sufficed to move his year's supply of food a thousand miles. To-day the day's wages of a common laborer at the seaboard will suffice to bring that man next-door neighbor to, or at a day's journey from, the farmer of the Mississippi valley. But, if the credit of the money in use is touched, or if the banking system is inadequate, the products cannot move.

If, then, within our great national domain there is not only enough to meet all our wants, but such an excess of food that we have in one year spare grain enough to supply the whole population of Great Britain with their daily bread, and about half the world or more with the materials for clothing, why has there been want, depression, loss, and compulsory idleness for a long period, and why have men been fearful lately that these adverse conditions might continue, or recur from time to time? In our commerce with each other as individuals we trust each other. In order that each human being in our land may find food, fuel, shelter, and clothing at his service day by day, the trade ot every day amounts to at least one hundred million dollars for every day in the year; yet the losses by bad debts in this trade, in a normal year, are less than twenty-five cents on each one hundred dollars of credit granted, and, even in a panic year, not over fifty cents on each one hundred dollars. "The trust reposed in and deserved by the many makes the opportunity for the fraud of the few." The vast proportion of men intend, either from principle or from self-interest, to do right, and not to wrong their neighbors. Even the swindler must support good government, because without it there would be no opportunity for him to cheat. Where all are swindlers, there can be no fraud, because there is no trust. When a proposal is made for the government to commit fraud, every trust is vitiated.

What, then, has been the cause of our recent adversity? Why is there any doubt of an immediate return to prosperity? If the material conditions are all that can be desired, what is the mental fault which proves our present incapacity to enjoy the huge advantage in position which we hold over all other nations? Can any reply be given to this question except one? As a people, are we not painfully lacking in common sense?

The prosperity of this country will be assured when common sense is applied to the three principal questions now pending.

First and paramount. The adjustment of the monetary system of this country finally and absolutely to the unit of value which has become the standard of the world's commerce,—namely, a fixed weight of gold.

Second. The adjustment of the laws for the collection of the national revenue to three fundamental principles of taxation :

A. All taxes that the people pay the government must receive.

B. Taxes upon articles of consumption must not be imposed upon articles which enter into the processes of domestic industry. When imposed on articles of common use, they must be put only upon those which can be spared without impairing the productive power of the individual or the nation.

C. All taxes should be so imposed as to work the least interference with the freely-chosen pursuits of the people.

Third. The banking system must be readjusted to the pursuits of peace by the removal of the prohibitory tax on bank notes, so that every section may be enabled to establish its own centres of bank credit under general provisions of law that will give assurance of the redemption in gold coin of all bank notes issued.

Assuming these conditions precedent to have been attained, as they may be, slowly, but surely, the nation will then, for the first time in its history, be fully able to take its naturally paramount position in the service of nations and in the attainment of its own general welfare. For the first time in our history we shall then be enabled to work our vast resources to the general benefit. What are these vast resources ?

The resources of this country are such that, in dealing with any period of which one may rightly attempt a forecast,—say, for the twentieth century,—we may assume that our power of production is unlimited, while our power of domestic consumption is limited. The problem before us, therefore, is one of distribution rather than production. What we have to seek is a wider market for the excess of our product of nearly all the necessaries of life, to the end that, in exchange for this excess, we may import and enjoy more of the comforts and luxuries.

In order that such an exchange may be made, we must not only have the excess to sell, but must remove all possible obstructions to purchases, so that other nations may be able to send their goods to us,—for nearly all commerce consists in the exchange of goods for goods.

We will pass quickly in review, first, the material resources of the nation ;

Second, the sources of the power of other nations to purchase our excess;

Third, the relative burden upon ourselves and other nations in respect to national taxes and military forces.

True progress in human welfare consists in a continuous and steady increase in the share, or proportion, of each year's product which is distributed in the form of wages or earnings; in lessening the relative part which falls to profits, rents, and interest; and in strictly limiting that part which is taken by taxation to the necessary work of government.

Bearing in mind these fundamental ideas, we may now review our own resources in connection with the disposal of our excess of product.

First. The prime necessity of life is food. It consists of grain, vegetables, meat, fish, dairy products, and the auxiliary products of hay and grass. In these pursuits more than forty per cent. of all who are occupied for gain in this country are directly employed; if to the number listed under this title be added laborers employed a part of each year on farms, workmen occupied in milling, meat-packing, and the like, and that part of those engaged in transportation who are occupied in moving food-products by rail and water, there is no reasonable doubt that one-half the work of the nation is devoted to the production and distribution of food-material.

In 1891, which was the year of largest product and greatest return in money ever reached, the area of land devoted to the production of grain of all kinds, potatoes, hay, and tobacco numbered, in acres, a fraction under two hundred million. Leaving out tobacco, and putting in garden vegetables, the result would be about the same. That area comes to a fraction under three hundred thousand square miles. That is to say, on one-tenth of our national domain, omitting Alaska, we produce such an excess of food-material that in a recent year our export of wheat and wheat flour only, had it all been taken by the people of the United Kingdom of Great Britain and Ireland, as most of it was, would have supplied a barrel of flour to each inhabitant for that year. That is about the average consumption of wheat flour in this country,—a little less than that of Great Britain. In addition to that export of wheat, other provisions were sent abroad in very large quantity. Yet, in the production of these crops under normal conditions, such as existed from 1873 to 1892 inclusive, the wages or earnings of those who are occupied in making them were from fifty to a thousand per cent. higher than in other grain-growing countries of the world.

In 1862 the area under these same crops was a fraction under eighty thousand square miles, and that was assiduously cultivated by hand. In thirty years—between 1862 and 1891—our population increased only one hundred per cent., but the area under the plough in grain and other food-crops increased more than two hundred and fifty per cent. The product in tons trebled. The farm value of these crops at lessening prices increased from $706,887,495 in currency—$487,045,482 in gold—to $2,283,999,656 in gold, or, on a gold basis, four hundred per cent.

Under the abnormal conditions which have prevailed since 1893, from which we are now emerging, this product was slightly diminished, but the value was reduced, by the paralysis of commerce and industry, more than seven hundred millions in 1895, as compared to the crop of 1891 almost similar in quantity. We are about to crush the men who brought on that paralysis, and we are now resuming the normal condition of supremacy in supplying ourselves and our neighbors across the seas with the chief supply of necessary food.

We have been enabled to do this work in the service of mankind by the application of science and invention to agriculture, of which there was very little prior to 1873. Setting apart the revolution in iron and glass, commonly referred to under the names of Bessemer and Siemens, but greatly developed and improved by American inventors, I can find no art listed under the head of "Manufactures" in which there has been so complete a revolution in method (by the application of modern mechanism and the science of dealing with the soil as an instrument of production rather than as a mine) as that which has occurred in agriculture. Yet, although this huge abundance and excess of production beyond our own possible consumption has been generated only from a tenth part of our land, the new methods have been as yet but half learned, and our crops as yet are but half what they will be, from the same area, as time goes on.

How much these changes mean in the household appears from a single fact which speaks volumes. I quote from a letter from the Deering Harvesting Co., which relates to the production of grain before 1873 and after.

> The advent of automatic self-binders has brought about a new order of things upon the farm, for, while in the early days the housewife had to provide for eight or nine harvest hands, she now provides for three. In the early days, when eight or nine men had to be employed, it behooved the farmer to move rapidly, and boys could not be depended upon to lay the grain for a gang of expensive men at two dollars to five dollars a day to bind and put in the shock. Now that harvesting machinery has been given intelligence, as it were, the farmer's boy lays twelve acres of grain so that a man and a boy can shock it. *The result of all this is that the farmer employs no additional help when the harvest comes.*

It needs but little imagination to conceive the relief from the drudgery of the domestic kitchen, soon to be yet more alleviated when my own simple inventions in the preparation of food, now free of patent rights, come into common use. From these figures and facts one may comprehend why the number of farmers in the great grain-growing States increased between 1880 and 1890, while the number of farm laborers diminished.

One other element of food may be treated. The late Spencer F. Baird, fish commissioner, once told me that the quantity of fish consumed by mankind was literally in the proportion of a drop of water to a bucketful as compared to the untold abundance of the ocean. That proportion may soon be increased to two drops by the adoption of cheap methods of freezing fish as fast as they are caught and put into the hold. This process is now in use in the British fisheries, in the expectation of sending frozen fish all over the United Kingdom in a perfectly fresh and wholesome condition.

We may next deal with clothing. The area devoted to the cotton fiber in this country, compared to the whole area of the cotton country, is about as one square in a checker-board. Yet upon that little patch we provide the material for cotton clothing for the greater part of the world. If cotton factories shall be built in China and Japan, their supply of the cotton fiber must be mainly sought with us. The cotton of India and China is relatively poor and unfit. That of Egypt, which seems to be our competitor but is not, is used for the finer spinning of Europe and this country, for which there is as yet no other source.

The whole export of cotton fabrics of Europe and of this country to China would supply less than forty million out of four hundred million at five pounds a head. We consume three or four times that quantity. Yet the Chinese as a nation are clad mainly in cotton fabrics, hand-spun, and hand-woven from their very short and inferior staple. When factories shall have been constructed in China, we may exchange our cotton fiber for their silk and ramie fibers, each being benefited. The earnings of our hands in the cotton fields are five to ten fold those of the poor Chinaman or Japanese. We cannot afford to spend time on the arduous handicraft of preparing raw silk, or what is called "ribbon ramie," when we can have that arduous work done for us in exchange for our cotton by those who are sometimes called "pauper laborers." When for one day of our high-priced labor we may secure the product of five, ten, or twenty so-called "pauper laborers," we are the more benefited, yet they share in the mutual advantage.

Our supply of flax waits only for the invention of processes by which the fiber in the straw, which is now burned, can be saved. It is now raised for the seed only, as we should long since have raised the cotton plant in the northern States for the seed only, had a plant suitable to our climate been discovered yielding seed without fiber.

Wool. As to this fiber the question arises: how shall our product be raised from insufficiency, and how shall it be saved from the bad handling which it now receives save in a few exceptional cases, making it compare so unfavorably with Australian and other clothing or worsted wool as to be almost a disgrace to our wool-growers? The value of our wool clip is about one per cent. of the total farm product. It might be readily increased in quantity and value, so as to become sufficient for our own abundant use, with an excess for export, were the wool-growers only protected by suitable legislation. Within an area of sparsely-populated territory in the middle south, comprising the "Land of the Sky," the Piedmont and Cumberland plateaus, northern Alabama, and the Blue Grass section of Tennessee and Kentucky, there is an area nearly as large as France, endowed with climate, soil, and conditions most favorable for breeding every variety of sheep, except those of the tropics, from which we derive coarse carpet wools. Every kind of food could there be supplied in greatest abundance. Sheep which had fertilized the cotton fields for the next year's crop could be carried through the winter on the refuse of the cottonseed-oil mills. There is but one thing needed to assure an excess of wool as well as of cotton, and that is protection. Not protection against Australian or South American wool-growers, but protection against the cur dogs which infest this whole area, with the possible exception of the Blue Grass region of Kentucky. The cur dog is the sign of conditions which forbid progress in all branches of agriculture in which sheep are the most important auxiliary. So long as the cur dog rules the States in which the wool-growing section most fit for abundant production is situated, we may remain dependent upon other countries for a part of our material for clothing.

We may now briefly consider shelter, the third factor in existence, — timber, stone, and brick.

We have been wasting our substance in the rapid destruction of our forests, but we may have learned in time that they must be renewed, not so much for a supply of building-material as to protect our domestic water-supplies and our sources of irrigation for arid lands. We are passing out of the period of timber construction in cities. The supply for country dwellings will always be ample. We are passing through the period of iron and steel construction, and presently we may reach a point in the upward spiral course of progress where we shall return to the prehistoric age of clay. The Boston Public Library is one of the first and best examples of construction mainly consisting of clay tiles within walls of stone,—more nearly fire-proof than any other building of which I have knowledge. One can not doubt that the main elements of construction, after a period of veneering upon steel, will consist of brick and clay tiles. Then buildings suitable for their purposes will be entitled to long duration, free of the danger of being twisted by fire or weakened by rust; but, before that period is reached, the art of brick and clay must be developed, and the almost lost art of mortar and cement must be recovered.

Is it not, then, true that we possess the highest potential in the production of the materials necessary for existence,—food and fibers in vast excess of any wants that can be developed in the next century, with the assurance of adequate shelter of any number of people that may be reached in that period? Yet without the control of all the metals that animate the arts, with the single exception of tin, our paramount control of the commerce among nations might not have been assured.

In this, again, our only present need is to find a wider and wider market for the excess of coal, iron, steel, copper, and lead, which the resources of almost every section present. While the mines of iron and coal in other countries are becoming more and more deep and costly in their working, and while some of the main deposits of ore from which steel can be made are approaching exhaustion, our own ore banks and coal-beds are but half opened, and, by improved methods, coupled with lessening cost and increasing wages, our exports of metal work are developing by leaps and bounds. Many of the examples of metallurgy now exported are products from the sale of which the highest wages earned by any class of artisans in this or any other country are recovered.

Between January 1, 1879, when specie payment was resumed with a gold dollar as a unit, and the spring of 1893, when the shock to the national credit caused by the silver craze brought on a partial paralysis of trade, commerce, and industry, our exports had once reached the billion-dollar mark. They are now once more rapidly approaching that mark, but this time they consist more and more of the highest type of finished goods, less and less of our crude materials. Even the slight additions to the free list and the small removals of obstruction to traffic in the materials used in domestic industry secured in the existing tariff law have given an opportunity to compete with other nations which finds its expression in this steady increase of the exports of finished goods.

Let any one glance for himself over the weekly manifest of exports from New York. He will find from this record that goods and wares of every kind pass out of the harbor to every quarter of the globe. If he will look further, he will observe that in every type of exports,—whether crude, partially manufactured, or finished goods,—the wages or earnings recovered from the sale are higher in rate and, more especially, in purchasing power than in any of the countries to which these goods are sent. They are also higher than in any manufacturing country with which we compete in supplying the increasing wants of the world. If the rate of wages were the prime factor governing the cost of production, and if upon that rate rested our power of competition, not one dollar's worth of this vast quantity of goods, representing our excess of products, could be sent out in exchange for the comforts and luxuries of which our imports mainly consist.

If the points made in the foregoing statement are tenable, it follows that, by way of the highest rates of wages yet recovered from the sale of products in this or any other country, we have attained a position which gives us assurance of being able to supply the increasing wants of the world as they become more and more developed by the ocean-steamship service, by railways, and by inland waterways. These conditions making for prosperity are due to our natural endowments, the principal elements of which have been noticed.

We now turn to what may be called the potential of demand upon us for the service which we can render. Upon an analysis of our exports, the startling fact is at once brought to our attention that our best customers are those who have been regarded as our sharpest competitors. For many years the United Kingdom of Great Britain and Ireland has taken one-half our total export. The British colonies and dependencies have taken ten per cent. The manufacturing nations—Germany, France, Holland, and Belgium—have taken twenty-three per cent., leaving but seventeen per cent. to all the rest of the world. The British colonies and dependencies themselves, aside from the mother country, buy more from us year by year than all the Spanish-American States on this side of the ocean. The reason is very plain. The nations which have adopted labor-saving inventions and which have applied mechanism to production with the greatest success are those which have attained the highest power of purchasing what they want. They do not exchange goods for goods with us in even proportions, because in the competition of science and invention we can deliver almost every manufactured fabric at less cost than they can, while deriving higher wages and better conditions from the service. They pass to our credit at the gold standard the huge balance of exchange on our merchandise traffic, against which we draw for our excess of imports over exports in our traffic with the non-manufacturing nations.

It will be remarked that the stability of our traffic with the great manufacturing States of Europe is assured by their stern adherence to the gold standard. Another element in their potential to buy from us the necessaries of life in very large measure, or the materials by which their manufactures are supported, all being more or less dependent upon us for such supplies, consists in the stability of their government, notably that of Great Britain and her colonies and dependencies. Wherever the English common law has been carried by the English-speaking people, coupled with firm administration, prosperity ensues,—better and safer conditions of life are assured. Witness the example of Egypt, where for the first time in recorded history the Egyptians are no longer despoiled. Again, during the last fifty years, wherever the English administration has been carried, the same opportunities for commerce are given to all nations that are granted to themselves. Whatever may be the variation in the duties upon imports in the English colonies and dependencies, they are uniform. The effort to colonize for the purpose of the sole control of commerce has been cast aside by the English-speaking people for half a century as a relic of ignorance and barbarism. Unfortunately for themselves as well as for others the same rule has not been adopted by the manufacturing States of Europe. Germany, France, Holland, and Belgium, although enjoying the advantages of a stable government at the present time, yet still grasp for the control of great sections of the earth heretofore unoccupied by civilized races, in order to secure to themselves an advantage in commerce over others. They have failed to do so, and will continue to fail so long as they hold to that delusion. Yet next to the demand of English-speaking people upon us comes that of these manufacturing States,—France, Germany, and the Low Countries.

One may not doubt that our power to supply the limited demand of Asia, Africa, and South America will increase with the removal of duties on crude materials or articles which enter into the processes of our own domestic industry.

The great undeveloped territory, the one great continent still open to increase of traffic, waiting for good government, a sound currency, and improved methods, is South America. Its purchasing power, even combined with other so-called Spanish-American States and islands, is very small, yet the continent of South America—of nearly twice the area of the United States, including Alaska, and occupied by a less number of people—is capable of almost unlimited development, under wholesome and healthy conditions, throughout the great interior plain and pampas of Argentine and Bolivia and in many other parts of the continent. It is waiting for the stability which has been elsewhere assured under the English common law, and also for a stable currency, without which no nation can greatly prosper. Recent developments in Mexico give ground for hope that the lesson has been learned, and that the evil influence of the Spanish Conquest and its development of rapine and plunder may, after four hundred years, cease to bar the progress of South and Central America, of Cuba and the Spanish main.

Finally, there are a few considerations aside from our abundant resources on which we may rest the future commercial supremacy of this nation. Our tax for national purposes in actual money per head is only half, perhaps less than half, that of the most lightly taxed nation in Europe. As compared to the value of our annual product, our national taxes are less than one-third of those of the most lightly taxed nation in Europe. But that advantage in money is but a trifle compared to our freedom from the blood tax and labor tax of standing armies and navies. Modern commerce turns from one side of the world to the other on the difference of a cent a bushel, a half a cent a pound, or a quarter of a cent a yard, on the great subjects of international commerce. Our national tax for all purposes does not exceed two and a half to three per cent. of the value of our annual product. It is to be doubted whether there is a nation in Europe in which the national tax does not take at least six and probably eight per cent. of the annual product, and from that, it is alleged, up to one third. This difference in money taxes only would, in a broad and general way, be more than equal to a cent a bushel, a half a cent a pound, or a quarter of a cent a yard on the great subjects of international trade. The one supreme advantage which this country possesses over other competitors is the principle of liberty, absolute free trade over a greater area and among a larger number of people than ever enjoyed that advantage before, and our freedom from the burden of a standing army or the need of any navy except such as is required for maritime police pending the time when, by a treaty even among the English-speaking people only, private property upon the sea may be exempt from seizure and privateering may be dealt with as piracy.

Were our standing army and naval force at this time equal, in proportion to our population, to that which burdens Germany and France, even including with them Great Britain, they would number nine hundred thousand men. That is almost exactly the number occupied in our railway service. The difference in our conditions and our advantage in potential in making use of huge resources may be measured by the contrast which might ensue were we subject to the divisions of race, creed, condition, and trade animosity which now make Europe one great armed camp, waiting but the word which may be spoken by an insane ruler at any moment to generate such wars as the world has never yet witnessed. If any one can imagine the difference in the service which our nine hundred thousand men now occupied upon the railways render to humanity as compared to the burden which would be imposed upon us if nine hundred thousand of our citizens were wasting their time in camp and barracks, supported by another great body nearly equal in number, then whoever brings that condition to mind will comprehend the forces which are making for our prosperity.

The one problem still at issue, without the true solution of which all these great material resources may be wasted while want takes the place of welfare, is the single question : has the struggle through which we have lately passed so far developed common sense among the masses of the people as to enable them to compel their representatives to take the money question, the bank question, and the revenue question out from the disorder of partisan politics, in order to assure a settlement consistent with the rules by which men of common sense and sagacity are governed in the conduct of all their private affairs ?

With the rendering of the verdict that the honor and integrity of the nation must be maintained and that freedom shall not perish in this land, the work of removing the restrictions with which we have retarded our own progress will only have begun. Is it not passing strange that the members of a community to whom no undertaking seems too great ; who have no long-standing prejudices of caste and class to surmount ; who make precedents rather than hamper themselves by them ; who but a century or a little more ago reversed all historic precedents by establishing the reign of law founded on the consent of the governed ; and who are in possession of resources so great that their burden is that of abundance, not of scarcity,—should yet be afraid of the very principle of individual liberty by which this nation lives and moves and has its being ? The powers of legislation were granted by our forefathers to the government, in order that the right of each and every man to serve his neighbor might not be impaired. Is it not time to ask ourselves whether we have not permitted an abuse of that power of legislation ? Absolute freedom of trade within our own country was so well assured by the very principle of personal liberty incorporated in the letter of the constitution that nowhere else are its benefits enjoyed over so wide an area or by so great a number of people ; yet, with that assurance of freedom of domestic trade, the door was left open for subtle and dangerous restrictions in the methods of distribution and for very great abuses of the power of taxation. May we not, then, take up the work which still remains for us to do, actuated by the same principle of personal liberty which, under the stress of civil war, has been so long and so much impaired? Must we not limit the functions of congress mainly to purposes of national defence and to its other very limited duties, no longer even permitting it to restrict the freedom of the individual, except so far as it may be necessary for the maintenance of the rights of others?

The nation has declared that its lawful unit of value, a dollar made of gold, shall be maintained, and that no kind of money which requires an act of legal tender to keep it in forced circulation shall be made use of, except for subsidiary purposes, and even then shall be subject to prompt redemption in gold coin.

The next duty must be to adjust the present system of banking, safe and suitable though it has been under the stress of war and even since, to the expanding conditions of trade and commerce born of peace, order, and abundance.

It will be our further duty to so adjust our system of national taxation that no man shall be restricted in his freely-chosen pursuit, whether in agriculture, manufactures, or commerce, so long as he impairs no rights of his neighbor, or only so far as it may be necessary to take from the community a small part of the general product for the support of the government. Should we not, then, choose as the subjects of national taxation only those articles which are mainly, if not wholly, of voluntary use? Shall we not spare the tax-payer from any burden by which his productive energy may be impaired, or by which the cost of the materials, tools, or mechanism with which he works may be increased? Daniel Webster once uttered the dictum that "there are many products which could be so well provided for us by the pauper laborers of other countries with whom we may exchange that we can not afford to do such work for ourselves."

It is only in recent years that the true motive and principle of commerce has been comprehended. Is it not a principle which may be stated in simple terms? Are not high wages or earnings in true money, or in what good money will buy, derived from or recovered from the sale of the products in which the cost of labor per unit of product is the lowest? Nearly a billion dollars' worth of our farm products and other goods and wares are now passing out of our harbors to every part of the world. The wages paid for the production of these and recovered by their sale have been from twenty to five hundred per cent. higher than the wages prevailing in the countries to which these goods are exported, or in the manufacturing countries with which we compete in supplying the increasing wants of the world. Is not the cost of labor the lowest in those countries in which the natural resources are the most complete and adequate, the application of science and invention most rapid and effective, the readiness and versatility of the workmen the greatest, and the burden of national taxation the least in ratio to the product from which it is derived? What other nation or State approaches us in the enjoyment of these conditions, nurtured under the principle of personal liberty, of equal opportunities, and of equal rights? What other nation or State can emulate us in the power of mutual service by which all commerce among men is governed, after the restrictions which we have imposed upon ourselves have been removed?

The result of the election has justified the forecast recently made in these pages. Party lines have been forgotten. Right-minded men have joined to sustain the honor of the nation with the same common purpose that brought them together when its life was threatened. If those who have now been charged with the conduct of the government for the next four years prove equal to the duty which has been entrusted to them, that support will continue to the end, so that freedom may be justified and the principle of liberty may finally govern the nation. If they should fail, others will surely replace them, until the paramount position in the great commerce of the world to which this country is entitled shall have been attained. When that time comes, the reign of law, under which life, liberty, and property will be safe from harm, will have justified the principle of personal liberty by the maintenance of peace and order. The power not only to supply our own wants, but to relieve other nations from a part of the burden of war debts, taxes, armies, and navies by which their progress in the true life of nations is now retarded, even if not wholly stopped, will have been realized.

What stands in the way of attaining the true place of which I have attempted to give a dim vision? Is it anything but our humiliating fear of under-paid labor, and our lack of full confidence in the quality and character of our people?

EVIDENCES OF HEALTH THROUGHOUT THE INDUSTRIAL WORLD.

By L. G. Powers.

IN examining a candidate for life insurance, a skilled physician seeks not only visible indications of health or disease, but physiological antecedents. He strives to ascertain the facts in the man's history making for good or ill health. This knowledge is even more important than that disclosed by a physical examination. It is essentially the same in any wise study of the health of the industrial world. The conditions of society on which must rest trustworthy promise of future business prosperity and stability have their origin or foundations in the past. Prosperity grows out of the life of a nation, and bears the same relation to it that fruit bears to the tree that produces it. A tree that has regularly borne much good fruit, if green of leaf and sound of branch and body, is reasonably certain to bear similar fruit in the future, even though barren this year. In contrast, the tree which in the past has produced no fruit, or only fruit of an inferior kind, can not by its blossoming give any promise of a desirable harvest in the future. It is the same with nations and their industrial life, with its fruitage of prosperity. We must consider not only the present indications of prosperity, the blossoms, as it were, on the tree of national industry, but also the quality and quantity of the fruitage of our national tree in the past. Recognizing this fact, the writer, in the present article will first briefly call attention to the facts in our industrial history that best illustrate our economic and social condition as a people, and are therefore the best indices of the foundation of our hope for, and belief in, future prosperity.

In 1870 the property of the United States was valued by the census authorities at $30,000,000,000 in currency, or $24,000,000,000 in gold. In 1890 that property had so increased in value that it was worth $65,000,000,000 in gold. In twenty years the people of this land added to their tangible possessions property to the value of $41,000,000,000 in gold. Stated in millions of dollars, this addition to our national wealth gives but a vague indication of the prevailing and improving industrial health and strength which rendered such addition possible. To give some clearer apprehension of the subject, the writer will try to express this gain in other ways. From 1870 to 1890 the United States added to its wealth almost twice as much as it was able to accumulate from its first settlement at Jamestown to the year 1870.

It was able to add a sum greater than all the inhabitants of the American continent had been able to save from the days of Columbus to the year named. Nay, more, these $41,000,000,000, added to our national resources in the twenty years ending with 1890, represent a sum greater than all the savings of the race from the days of Adam to the first, and possibly the middle, of the eighteenth century. In other words, our nation in twenty years accomplished more in the way of housing and providing shelter for its people and giving them improved methods of production and transportation and better food and clothes than had been achieved by the race before the year 1700.

The wealth thus accumulated may be considered in still other ways. In 1870 the population of the United States was about 38,000,000, and in 1890 it was over 62,000,000. The savings of these millions for the whole twenty years were, on an average, over forty dollars per annum for every man, woman, and child in the nation. In any seven years of this period the average family saved as much as it was worth in 1850, and in sixteen years accumulated as much as it possessed in 1870,—the beginning of this period.

But more important in this connection than any of the facts given above are those showing the distribution of these vast accumulations of recently-acquired riches. The census of 1850 estimated the number of real-estate owners in the United States in that year as 1,500,000. Therefore, at that time, according to the census, 6.47 per cent. of the population and 35.95 per cent. of the families in the country were possessed of real estate, either free or encumbered with debt. The census of 1890 reports 6,066,417 families living in houses or upon farms owned by themselves. Of this number 4,369,527 owned their farms and homes, free from all mortgage encumbrance. In addition, there were many other owners of real estate, besides these owners of houses and farms used as homes. The owners of homes free from debt made up 6.98 per cent. of our population and 34.93 per cent. of our families in 1890. In other words, there were relatively as many people owning homes free from debt in 1890 as there were owning all kinds of real estate in 1850. The people owning both free and encumbered homes in 1890 constituted 47.90 per cent. of the families and 9.69 per cent. of the population. Taking the family as the unit, we find that the ownership of property in 1890 was 33 per cent. more widely, and hence more equitably, distributed than in 1850. Taking the individual as the unit, the improvement is equal to fifty per cent. This progress may be shown in another way. In 1850, of the families of the toilers upon our American farms 20 per cent. were slaves, and not less than 27 and possibly 32 per cent. more were laborers for wages, or tenants. Not more than 53, and possibly not more than 48, per cent. of the families residing upon and obtaining their living by tilling the soil were owners of the land they cultivated. In 1890 at least 63 per cent. of such farm families owned the land tilled by them, and less than 37 per cent. of the heads of families toiling upon farms were tenants or laborers. The relative proportion of farm tenants had doubtless somewhat increased in forty years, but that of slaves had vanished, and that of laborers had greatly decreased. The relative increase in the proportion of farm owners was greater, however, than that of farm tenants, and the percentage of heads of families toiling on the farms as laborers was but little more than one-half that of either free or slave laborers in 1850 or 1860. All these facts are indications that show how the tree of our national life has increased its fruitage,—the prosperity of the masses of our people. The facts cited show that, whatever may be our present transient indications of prosperity, we have in them from 33 to 50 per cent. more ground for expecting such prosperity than had our fathers in 1850.

The accumulation of wealth and the improving equity of its distribution have been rendered possible only by the further fact of the regular and continuous employment at remunerative wages of a greater proportion of our citizens than ever found work in any other nation on the globe. In 1890, of the men and women over ten years of age working at some remunerative occupation, 84.5 per cent. according to the United States Census had regular and continuous employment for the whole of the year ending May 31. The other 15.5 per cent. were employed, on an average, two-thirds of the time. The unemployed for the year averaged, therefore, only 5.01 per cent. of the total number engaged in gainful occupation The average worker was, therefore, employed 95 per cent. of the time, and was idle 18 days out of the 313 working days of the year. The same fact may be stated by saying that, on an average, 5 per cent. o. the people were in 1890 continuously idle, and 95 per cent. continuously employed. This showing for 1890, presented by the United States census, was materially better than that found by the Massachusetts census for 1885. The 95 per cent. that in 1890 were, on an average, employed all the time received wages that, in gold, were materially greater than those paid in 1870. In fact, from 1870 to 1893 wages, measured by the gold standard, had more or less regularly risen, and, owing to the falling price of the great mass of articles manufactured by machinery, the purchasing power of those wages increased to a still greater extent. In 1891 a week's wages in the United States would buy 40 per cent. more than in 1873. The saving and spending power of the masses was improved to that extent. This increase in the saving power explains the unprecedented accumulation of riches to which attention has already been called. The increase in spending power enabled the masses to purchase an ever-increasing abundance of the many articles of utility and luxury. The purchase of books, papers, good clothes, good food, articles of ornament, watches, and musical instruments increased several fold faster than population. These facts, together with those before alluded to, are the best possible evidences of health and vigor in the economic and social life of the nation. They mark the existence of the essentials of a wonderful prosperity, which we, as a nation, need only to give half a chance to develop.

As a healthy man may be seized with a most violent attack of sickness, or as the best bearing of trees may have its fruit destroyed in any given year by a chilling frost, so the general prosperity of our nation was checked by the panic of 1893. That panic began with a lessened market, and thus a smaller commercial demand for the great staples of the farm and the shop. This change in demand directly led to lower prices and restricted incomes for the producers and dealers. It also indirectly lessened the opportunities of the wage-earners. Vast numbers of the latter were thrown out of work, and the average wages of the toilers were lessened. The number of the unemployed and irregularly employed became, in all probability, double, and possibly three times, that of 1890. This gave for the winter of 1894 at least seven and possibly ten million men, women, and children with more or less irregular employment, and a total average number of workers idle all the time equal to, if not in excess of, one in ten, and possibly one in eight, of all those desirous of pursuing gainful occupations. The wages received by the toilers, as a whole, were decreased over one-third from the grand total of 1890. Capital suffered with labor. The incomes of the moneyed classes were lessened, and financial ill health, or depression, as we call it, presented its symptoms on every hand. Now comes the critical question of this paper. How far has the nation rallied from that attack of 1893, and what are the indications of such a revival of business as will promise us the old-time prosperity in our land, the renewed fruitfulness of the tree of our industrial life?

In January or February, 1894, the number of unemployed or irregularly employed was very great. Since that time there has been an irregular improvement. The summer of 1896 saw the percentage of idle and irregularly-employed workers not more than three-fourths of what it was in the winter of 1894, or about one and a half to two times as great as the average for 1890. Uncle Sam had passed the critical stage of his financial attack, and was on the high road to speedy recovery. The nation gave indications of a steady gain, the beginning of a new era of prosperity, provided only it could be kept free from the disturbance of financial quacks with their poison of free silver and its *sequelae* of commercial distrust and stagnation. This, at least, was the diagnosis of the case made last autumn by the advocates of commercial honesty and sound money. Those advocates declared their belief that revival of business waited for only one essential requisite,—namely, an end of uncertainty by the victory of sound money at the polls. The two weeks next succeeding the election, according to the reports of the daily papers in the United States, saw the reopening of 284 mills, employing a total of 164,635 men. Granting, if it is claimed, that one-third or one-half even of this army of toilers were given work by the opening of factories that run only in the winter, there are left from eighty-five to one hundred thousand operatives who returned to the ranks of industry in two weeks after Uncle Sam found security against the threatened poison of free silver. That army of men set to work since election is not less than five, and possibly exceeds ten, per cent. of the number of idle in 1896 that would have been regularly employed in the best year for labor that this or any other country ever witnessed. Multiply by ten or twenty the chances for labor that have opened since November 3, and we return to the industrial health of the strongest nation on the globe in its most prosperous year. Is it difficult to believe that this country can, in the next twelve or twenty-four months, find ways of setting this extra number of men at work? Let us see.

For example, the opening of as many miles of new railroads as were constructed in 1890 would, in grading, rail-making, and rail-laying, and in the construction of needed cars and locomotives, open to labor one-third the opportunities for toil required to set this army of idle men at work. Other writers in this number discuss the probabilities of expansion and development in railroad and other great engineering and business enterprises, that will thus transfer this army from the ranks of the idle to those of the toilers. In this connection the writer wishes to call attention to the narrow margin which at present separates us from the greatest era of prosperity that this or any other nation ever saw.

The needed employment of labor in constructing new railroads or in other enterprises of widely different character will hinge upon the profitable return for human labor on the farm and in the work-shop. What, then, is the outlook for labor in these two great domains?

As he scans the signs of the times, the writer finds a favorable outlook in both.

Turning to the monthly summary of the commerce of the United States for September, 1896, it is to be noted that the value of the products of agriculture exported for the nine months ending with September, 1896, had a value of $416,364,411. This is $60,386,-505, or nearly 17 per cent., greater than for the corresponding nine months of the preceding year. To gain a clear idea of the promise of agricultural prosperity involved in this fact, a few words are necessary concerning the cause and extent of the agricultural prosperity that prevailed from 1879 to 1882 in this country. *The years named saw a greater actual and relative return for their labor to the tillers of the soil in the United States, as a whole, than was ever realized by such workers in this or any other country.* The annual income of the farmers of the nation was in those years at least $400,-000,000 greater than it averaged for the fifteen years that preceded, or the thirteen years that followed. But that period of phenomenal farm prosperity was immediately preceded by one of low farm prices and reduced farm incomes that was more severe, on an average, than the one experienced since 1893. The change from the period of low farm prices to one of higher began in 1879 by an increase in our exports of agricultural products similar to the one noted above for the last nine months. It began with an advance of farm prices due to this increased export, caused largely in the earlier case, as in the latter, by crop failure in other quarters of the globe. The trustworthiness of the promise of better times involved in our recent advance in the prices of agricultural staples may be seen by noting the following facts, showing its extent when compared with the corresponding advance that heralded the most phenomenal era that began during the season of 1879.

Wheat, as is well known, is the great staple of agricultural export raised in the north and west. The advance in its selling price in the last six months has been neatly as great as that witnessed in the corresponding six months of 1879. Cotton, the second great staple of agricultural export, the leading staple of the south, has likewise advanced in price in the last two years more than it did in the corresponding period at the beginning of the four years of wonderful prosperity mentioned. These facts, taken in connection with the crop and industrial conditions in other lands, indicate the beginning of an era of farm prosperity even greater than the one experienced from 1879 to 1882.

The figures showing the increasing exportation of live stock and live-stock products lead to the same conclusion. One great factor in the advance of prices of farm products that occurred in 1879 was the increased demand in Europe for American cattle, and their primary and secondary products, usually classified under the general name of provisions. The total value of the exports of animals and provisions for the year ending June 30, 1879, was $128,346,404; for 1880,

$142,925,362. The increase from 1879 to 1880 was $14,578,958. The corresponding total for the nine months ending September 30, 1895, was $120,840,875; for the nine months ending September 30, 1896, $132,246,924. Here is a gain of $11,406,049 for nine months. A like gain for the year will make over fifteen millions of dollars, or more than was realized in the first year of exportation at the beginning of the era of wonderful farm prosperity,—1879 to 1882.

Since the increased foreign demand for the products of the American farm began to be felt last summer, prices of wheat, oats, hay, beef, cotton, pork, steers, hogs, and most other staples of the farm have advanced in selling value. It is true that we have not yet reached that ideal of the farmer,—dollar wheat. Neither have we reached the earlier limit of maximum prices. We have, however, in all, as in the case of wheat and cotton, witnessed *as great an advance in price as was realized by the farmers in the corresponding period at the close of the financial depression, 1874 to 1878, and the beginning of the era of extraordinary prosperity that followed it.*

In another way can be shown the extent of our progress towards agricultural prosperity, and incidentally towards general prosperity,—for general prosperity always results from farm prosperity. Wheat prices have advanced so that, at the writing of this article (December 1), the selling value of wheat in Minneapolis is greater than the simple average gold price realized by the farmers of Minnesota, Wisconsin, Missouri, Kansas, Nebraska, Iowa, Ohio, Indiana, Illinois, and Michigan from 1860 to date. In the same way the prices of beef cattle, which were extremely low for the greater share of the year last past, have advanced, until in Chicago they are now nearly equal to the average for the last twenty years, and are in excess of the average in gold for the fifteen years preceding 1878.

This question of possible prosperity or adversity in store for us as a nation is of so great importance that it is worth our while to look at it in still other ways. It has been asserted by many that the prices of all agricultural staples have fallen since 1873. Some prices have fallen, but others have not. Some have fallen in one section, but advanced in others. Taking the average of all the great staples of the farm,—corn, oats, wheat, rye, barley, buckwheat, hay, potatoes, and tobacco,—and the livestock,—horses, mules, cows, oxen, sheep, and swine,—in the ten central Mississippi valley States already named, there has been no general fall of prices since 1860. On the contrary, there was a positive, though irregular, advance down to 1893. Since that year there has been a decline, but one that leaves prices, on the average, as high as in other periods of exceptional financial depression. Taking the price of 1873 as the basis of comparison and calling it 100, the Minnesota bureau of labor found the average price of those nine crops and six animals to have been as follows, by periods of seven years: 1862-66, 91; 1867-73, 108; 1874-80, 100; 1881-87, 116; 1888-94, 103. Thus the price in the last of these seven-year periods averaged 3 per cent. greater than in the seven years from 1874 to 1880, and over 12 per cent. greater than for the war period,—1862 to 1866. They were below the prices of the periods of exceptional farm prosperity already referred to in this article. The general trend of upward prices from 1862 to 1894 was interrupted by the panic of 1893, which lowered prices for that and subsequent years. The average for 1895 is expressed by the index number 84, or about 19 per cent. less than the average of the seven years ending with 1894. The advance of farm prices already noted carries the average back nearly, if not quite, half the way to the average of the seven years ending with 1894; above the average of the war period, 1862 to 1866; and nearly up to that of the years 1875 to 1878. Who can contemplate such facts as these, and not see in them abundant and trustworthy promises of a return to great national prosperity?

But, while farm prosperity always causes general prosperity, its indices are not the only evidence of returning industrial health and strength. We can find the same in the records of manufacturing enterprise. In the nine months ending with September 30, 1896, the value of the domestic manufactures exported to foreign countries was $184,792,443, while, for the corresponding nine months one year before, it was only $145,793,834. Here is an increase of $38,998,609, or more than 21 per cent. This is a larger relative increase than that experienced in agriculture, and a far greater increase than that achieved in manufacture during the first nine months of the prosperity that began in 1879. The mine products exported increased in the same nine months from $14,246,029 to $15,703,835; those of the forest from $23,375,317 to $27,417,136. Our exports of silver, of which we have an excess, increased from $38,664,610 to $46,441,041, while our exports of gold, which we desire to use as money, decreased from $73,190,282 to $55,570,421, and our imports of the same increased from $28,839,939 to $64,888,856.

Some of these indications of prosperity are but blossomings on the tree of our national industry. They are, if not fruit, the blossoms of a tree that has always been very fruitful, and that now shows great vigor in putting out these evidences of renewed life. Will they not yield an early and abundant industrial harvest, if only we keep that tree watered with the elements of business confidence and free from the blight of financial uncertainty that has so lessened its fruitfulness since 1893?

PUBLIC CREDIT AS RELATED TO ENGINEERING ENTERPRISE.

By Gustav Lindenthal.

THOSE who remember the severe business depression from 1873 to 1879, and the revival of business prosperity in the autumn of 1879, which thereafter continued almost uninterruptedly for twelve years, will have observed that the revival was manifested in the construction of large engineering works. While in the six years from 1873 to 1879 there were built 11,499 miles of new railroads, in the following six years (1879 to 1885) 46,594 miles were built, or four times as many, and from 1886 to 1892 were built again 47,434 miles.

The expenditure of five billion dollars in twelve years for railroad construction alone, in addition to other engineering construction on a large scale, gave an impetus to every form of industrial production, which would have remained unabated but for bad financial legislation, beginning six years ago, and the consequent weakening of public and private credit.

Some of the newly-built railroads and other new improvements were, no doubt, ahead of the normal growth of the country, and not always good investments; but it cannot be denied that they largely accelerated it, contributed to quicker settlement and development, and added enormously to the general wealth of the nation. It was rather a business than an engineering problem to nurse the properties along until they should become fully self-sustaining, and thereafter very profitable.

Later, in 1888, commenced the development of the electrical railroads in all the larger cities and their vicinities, which, with the affiliated manufacturing interests, required the additional outlay of very vast sums (estimated at $1,200,000,000) for construction purposes, and for establishment of the new electrical industries. In 1893 came the depression which has lasted up to the present time.

A review of the causes which brought about the revival of prosperity in 1879–80 may enable us to judge whether a revival from the present stagnation is likely to occur soon. First among the causes was the fact that, irrespective of the industrial and commercial depression during the six years preceding 1879, the government had a sufficient revenue, not only for its ordinary expenses, but also for reducing the large public debt, incurred in the civil war. Next, the bad effects of the previous over-speculation had disappeared, and people were beginning to economize and save. No one was counting any longer on a boom, but nearly everybody had settled patiently to the conviction that an improvement could come about only gradually. Bad debts had been adjusted, living expenses curtailed, and the conviction arrived at that hard work alone could gain a living and a competency.

All these circumstances contributed to restore and strengthen business confidence almost imperceptibly, and when, from necessity, and afterwards from speculation, a large expansion of building operations, and of every business connected with them, took place, it was the progress and growth of a healthy body.

Had the first causes continued to operate; had the government continued to redeem out of revenue its indebtedness in the form of bonds, and afterwards that in the form of greenbacks; and had it continued to be economical in its expenditures, as it was until 1890,—no panic would have occurred in 1893. But a contrary policy was set up. Simultaneous with the incurrence of a large new indebtedness (for entirely useless silver purchases) was a very large increase in government expenditures, without a corresponding increase in revenues. The increase in war pensions alone, for the four years since 1890, amounted to $280,000,000, and of itself was enough to cause the recurring deficit since that time. Other items of the government expenditures were also increased, but in lesser degree. The unwise policy and profligacy of the government could not fail to shake the faith ot the entire business world in its solvency and honesty. In 1893 the first symptoms of distrust appeared; a remedy was applied under great public pressure in the repeal by congress of the silver-purchase laws; but no serious attempt was made, or has since been made, to prevent a deficit. Complete recovery of public credit did not come, and the business depression continued. The government protected itself temporarily by the sale of bonds. The distrust continued, and assumed an acute form during the last presidential campaign, owing to the threatening danger of free silver coinage. The result of the election just held indicates the overwhelming desire of the people for a policy in the interest of social order, honesty, and good faith.

But the election itself is not the solution. This must now come through proper laws curtailing expenditures, increasing revenue, and affording better banking facilities. While we have reason to hope for an improvement of our public credit, with which the private credit of the business world is so closely connected, it is still essential that congress shall pass the requisite remedial laws.

It is an acknowledged fact that, in in all countries having a high public credit, private capital for large undertakings is plentiful; public and business credit are indissolubly connected. Thus, for credit to become high and business confidence firm, the government must set the example of a well-ordered financial policy, making the outgo fit the income. With the clearing up in the public household should go hand-in-hand the clearing up in the households of business, as from 1873 to 1879. Prudence and economy are needful, therefore, not only in our government expenditures, but also in our business affairs, that we may effect a complete recovery from the unhealthy condition of the last six years.

A revival of business prosperity will assuredly again manifest itself in the construction of large engineering and income-producing works. We have to distinguish between public works for which the capital is provided from taxation—as, for instance, all harbor and river improvements, city improvements generally, and canals and bridges built at public expense—and public works built with and owned by private capital for purposes of investment.

Included in these latter are our entire railroad system, the largest in the world, and larger than that of the whole European continent: our electric power and light plants; elevated, cable, and electrical railroads; gas works; and a thousand and one other public works,—the whole representing an investment estimated at $14,000,000,000, a sum many times greater than the sums obtained for public works from taxation. It is, therefore, of the first importance for the progress of our country that private capital should be had readily and cheaply. It can provide and manage many public improvements better, more cheaply, and more quickly than can our in many ways crude public administration working with public funds.

When business confidence is unshaken and public credit unquestioned, experience teaches us that private capital is eager for investment. Interest is low, and consumption is large. The money paid out in the construction of new improvements finds its way into the channels of trade, and, being turned over and over again, begets more frequent profits and larger savings, which constitute new capital ready for investment in additional improvements. Thus, if the development of our country, with its great and unparalleled natural resources, could take place steadily and without interference from financial mislegislation, it could not fail to grow immensely wealthy. All the foreign borrowed capital, estimated at over $4,000,000,000, would be gradually repaid, leaving the nation free from obligations, private or public, to any capitalists but its own. We could keep the interest at home, as the rich European creditor nations do. We should aim to attain the greatest prosperity and the largest measure of political and industrial independence by wise economy and saving, and not by the political nostrums of permanent protective tariffs and fiat money.

Be it remembered, as an instance and illustration, that Germany, in the beginning of its modern industrial improvement and before the railroad era, was a comparatively poor country, with only the small resources of an agricultural nation. It had not, at the end of the Napoleonic wars, the population or the wealth even that it had at the end of the sixteenth century, when it was the richest country in Europe, when it had the largest and most highly developed manufactures, the most extensive continental commerce, and the greatest banking houses, and when the greater part of the gold and silver wealth of newly-discovered America had found its way through the spendthrift Spanish channels into the strong chests of its thrifty and industrious burghers and merchants. The incessant wars and devastation, beginning with the Thirty Years' War, and lasting well into this century, reduced the population, and led the country to a state of poverty, from which it began to emerge only sixty years ago. In the beginning of the seventies, Germany was yet deep in debt to other nations. A large part of the government debts, and of its railroads, water and gas works, and other like remunerative investments, were owned by foreign capital,—mostly English, Dutch, and French. Twenty-five years of uninterrupted peace enabled it not only to repay all the foreign capital it had borrowed, but to accumulate more than enough for internal improvements, some on a vast and unparalleled scale, and its banks and capitalists have made large investments—not always profitable—in Australia, Africa, South America, and the United States. No foreign capital can find investment in Germany any longer. If all this was accomplished by a nation maintaining a large standing army, what could not be accomplished by the United States, infinitely richer in resources, if its natural development were not artificially interfered with by ignorant legislation and agitation. Not only would the United States likewise be able to pay back in less than twenty-five years all the vast sums of capital borrowed abroad, but it would gradually and surely change from the largest debtor nation, which it now is, to the wealthiest creditor nation of the world, and thus become the most influential promoter of civilization in its highest sense, the most powerful republic and agency standing for peace.

Foremost among the men who can and do greatly aid in the development of the nation's wealth are the engineers. They are habituated to the responsibility of the expenditure of large amounts of money in the execution of costly works. Their training is such that economy, careful attention to details, and the application of the laws of causation to the affairs of life, become a second nature with them. Whenever their independent judgment has been called in to direct the business management of any undertakings or of public works, it has always had beneficial results. The railroad and manufacturing corporations that have followed that policy are among the most prosperous. On the largest and probably the richest railroad in the United States, almost all the general officers, including the president, are trained engineers, who have grown up with the property. It is as yet the only railroad with a systematically-managed sinking fund for the gradual extinguishment of its mortgage debt.

The engineer is preëminently the great economizer in all branches of material wealth. It is the engineer's work that has enabled one man to produce food for two hundred and fifty persons, whereas forty years ago he could produce for only thirty persons. It was his work that brought down, by systematic economies in construction, maintenance, and operation, the average cost per ton-mile from 2 cents to 0.2 cents; the price of steel rails from $160 per ton to $21; the price of locomotives from $13,000 to $5,000; the cost of earth-excavation from 50 cents per cubic yard to 10 cents; the cost of dredging from $1 to 12 cents; the cost of bridge construction from 8 cents a pound to 3 cents; and so on, throughout every branch of engineering. Not all the taxing powers of the richest government could produce the sums which are being yearly saved by engineering science.

Although it must be expected that railroad-building in the United States will not be much longer a measure of prosperity, as the country will soon have about all the railroads it needs, there are other fields of engineering work, which have only just been approached, and where great profits are awaiting the investor.

There is, for instance, the greatly-felt need of cheap railroad-feeders. The want is in a fair way to be supplied by electrical traction roads, not only for passengers, but also for mail, express, and freight. These must be built with private capital.

A very large field for the economizing methods of the engineer will be found in the construction of good country roads, the demand for which has become stronger of late years, because of the greater number of wheelmen using them. These must be built with public funds. The demand will become irresistible with the evolution of the horseless carriage and wagon. It cannot be gainsaid that the United States, of all civilized countries, have as yet the poorest wagon-roads. Our greatest obstacles in getting better ones are not want of money so much as the too frequently ignorant and wasteful political management of public funds and properties. Fine roads can be built and maintained only under a thorough and permanent engineering organization and supervision, which should cover the entire United States.*

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* Throughout Europe the labor of convicts is used for this work, in which it does not come into competition with free skilled labor.

The oldest organization of the kind (dating from 1671) is that of France, and from it the public road departments in all countries have been more or less copied. If all the money at present wasted, by unskilful and haphazard methods, on road-building and repairing, were used, together with convict labor, under the direction of such a department, the country from one end to the other would be provided in twenty years with as fine roads as any in Europe,—a great addition to the national wealth, begetting private wealth simply as a result of wise economy in the expenditure of public money.

The most important center of engineering activity with a revival of business prosperity will be New York and vicinity. The large works planned and pressingly needed are almost all for the purpose of increasing the convenience of local transportation and lowering its cost.

First to be commenced will be the new East river bridge, with about twice the capacity of the existing Brooklyn bridge. It is intended for the local traffic between New York and Long Island. So great was the recent financial depression that the cities of New York and Brooklyn, which enjoy the highest financial credit, could not obtain the money for this and other public works before the last election. But, immediately after the election, business confidence was sufficiently restored to enable them to sell their bonds at a premium, and the work may now be pushed with vigor.

Another costly bridge over the East river, but to be built with private capital, is the big railroad bridge across Blackwell's Island. The contracts for the foundations and iron work have been made. Its cost will be more than $10,000,000.

But the largest work of all, and the largest single structure ever built in the history of mankind, will be the gigantic bridge over the North river, contemplating a single span of 3,100 feet over its entire width, and which, with all the accessories of land and approaches, will cost $40,000,000. It will carry eight railroad tracks, besides roads for bicycles and promenade, and will afford entrance into New York for thirteen railroads. Hoboken, Jersey City, and the populous country in New Jersey back of them, will be connected with the business district in New York, centering around Twenty-third street. The engineering difficulties, which at first seemed to be insurmountable, are now considered less serious than the legal and financial difficulties. A large undertaking like this, likely to interfere with the valuable property interests of many persons, must unavoidably pass through a long process of litigation to establish its legal rights. The location at Twenty-third street has been secured only after a litigation of four years, finally decided by the supreme court of the United States favorably to the company. The great labor of organizing and preparing the necessary broad financial foundation can be successful only after the legal status of the work has been proven sound and unassailable. Capitalists then invest with confidence, and, with the return of normal business conditions, the funds can be readily obtained. More particularly foreign bankers, who must necessarily be consulted, would not make engagements for furnishing capital otherwise. They certainly do not do so during a time when their clients are selling American holdings right and left, as they did during the recent panic. All this will, of course, change, and is changing, with a return of business confidence. The undertaking is fully prepared, and merely awaiting returning confidence.

Another bridge over the Hudson river is contemplated at Fifty-ninth street. It has designedly attracted much public attention, but as yet has not gone through the necessary legal contention. By reason of its location too far north, away from the established principal lines of traffic, this project may obviously be regarded as a work possible only at a much later time.

A valuable improvement, of local importance, will be the completion of the tunnel under the Hudson river. It was commenced more than twenty years ago, and is half finished, but had to contend with many engineering and financial difficulties. Foreign capital is engaged also for this undertaking, awaiting merely better times. The tunnel is to be used only for local traffic, on two tracks, with electric cars from shore to shore, access to it being had by means of shafts.

Another important tunnel project, work on which will shortly be commenced with complete engineering and legal preparation, is the one for rapid transit with electrical power from the lower part of Jersey City, at Exchange Place, to Cortlandt Street in New York, and thence under the city and under the East River to Atlantic Avenue in Brooklyn. Its cost will be $25,000,000. The relief it will furnish to the dangerously congested passenger traffic, particularly to Brooklyn, cannot come too soon.

The most pressing improvement in New York itself, which, it is hoped, will be now soon realized, are the so-long-debated rapid-transit routes to the northern part of the city. After long delays, expensive plans were prepared, but the courts prevented their execution, on account of their great and uncertain cost. Had private capital been intelligently encouraged to solve the question under proper safeguards to investors, rapid transit would probably be in operation by this time without any expense to the city, on the same plans which were accepted as the most practical and economical for London,—namely, on the deep-tunnel plan of Engineer Greathead. His system was proposed for New York by capitalists ready to build it. But the offer seems to have been undeservedly ignored.

The capital, which thus will be put into circulation by the construction of the new engineering works for New York City alone, will reach $140,000,000.

Among the proposed great improvements near New York, and depending upon private capital, are the new terminal station in Boston and the elimination of railroad grade-crossings in Bridgeport, Conn., Newark, N. J., Jersey City, Philadelphia, and other important cities, involving a total expenditure of $90,000,000 (estimated).

Beside the large amount of railroad work awaiting construction throughout the United States, there is canal work on a large scale, the need of which is becoming very pressing. The deepening of the Erie canal has already begun. The funds for it—$9,000,000—are provided by the State of New York. For the construction of deep-water canals between Lake Erie and Lake Ontario and between Lake Ontario and the Hudson river, and of the Cape Cod canal, private capital will be employed to the extent of about $200,000,000.

The largest canal work now under way is the half-finished Chicago drainage canal, to connect Lake Michigan, through the Illinois river, with the Mississippi and the ocean. It is designed to meet the double purpose of providing drainage for the growing city of Chicago and making it the largest port for inland navigation. Its cost of $30,000,000 is borne entirely by the city of Chicago.

The list of important engineering works in the United States for traction roads, irrigation systems, aqueducts, hydraulic and electric power plants, bridges, shipping docks, tunnels, water and filter reservoirs, etc., etc., awaiting construction and better times could be prolonged for many pages. Taking only those enterprises far enough progressed for immediate construction, they will require the expenditure of $900,000,000 of private capital to begin with, which is nearly double the amount expended on railroad and other engineering construction for any one previous year of the most active era. But suffice it to say that, the beginning once made, the business activity will be greater than it ever was before,—far exceeding that of the prosperous period which began in 1879-80. Since then, the population of the country has nearly doubled, and its wealth has quadrupled. Capital is waiting to come forward, and there is no end of opportunity for its profitable investment.

But public credit and public confidence cannot reach the highest standard, unless there is unquestioned security of property.

When, during a visit to London last winter, I had a conversation with the late James H. Greathead, chief engineer of the new underground railroad in London (crossing under the Thames from the Waterloo station to the Liverpool Street station), I inquired of him whether his company had much trouble in raising capital for their undertaking, and what interest they were paying.

His answer was: "After we had obtained our legislation from parliament, we had no trouble in getting all the required capital at three per cent."

"Do you mean to say you are paying only three per cent. on the cash received? That would hardly be half enough in the United States for a public undertaking with private capital."

Mr. Greathead answered: "That is all we are paying over here. The investors are satisfied to get that, and expect more only when we earn it. We can get money here at a low rate of interest, because our parliament protects property. Can you say the same thing of your congress and your legislatures? You cannot expect to get money as cheap as we can."

It was a significant comment, and by no means an isolated one. The impression unfortunately prevails abroad more than it should that property and investments are not secure in the United States in the same degree that they are in England, or in the civilized parts of the European continent, against attacks from ill-considered or vicious legislation. The relief with which the adjournment of the legislature or of congress is usually received is not unjustified.

It is more than questionable whether, in any other civilized country, a wholesale confiscation of property, and the overturning of social order itself, could have been proposed in the barefaced manner in which it was during the last presidential election. And the one not unfounded fear is that these attacks may be repeated in the future, merely changing their form from the silver and riot issues to some other issue of equally baneful influence upon business morality and upon the security of property.

PROGRESS AND PROMISE IN AMERICAN SHIP-BUILDING.

By Lewis Nixon.

IN discussing the progress of ship-building, I shall confine my observations to the steam marine; not because no advancement has been made in construction of sailing vessels, but because almost the whole volume of popular interests centers on steam and the development of the steamship.

To avoid tedious and irrelevant detail I will date the era of the modern metal-built steamship in this country from the laying of the keel of the George W. Clyde—about 1869.

Some other coasting steamships were built in that and the two succeeding years, and in 1872 the Cramps entered the transatlantic field with the four ships of the original American Line,—the Ohio, Indiana, Illinois, and Pennsylvania.

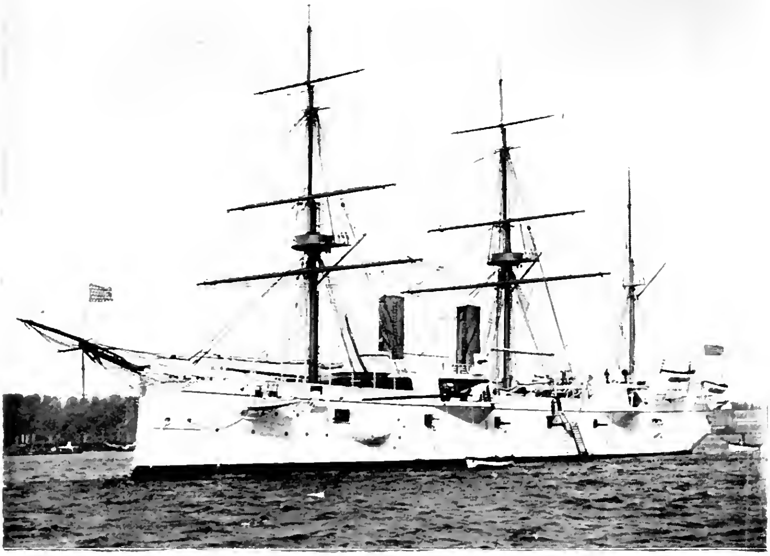
Roach soon followed with various products of the Chester shipyard for the Pacific Mail, Brazil, and other lines, and Harlan & Hollingsworth of Wilmington struck and held the pace of a good second to their larger neighbors.

But, ably and promisingly as this new era was ushered in, its progress did not sustain the promise of its inception. Good ships were built, and the American practice in yard or shop did not lag behind that of English builders. The market for their wares, however, did not rise with the development of facilities. The government, which in one way or another must always foster any successful ship-building industry in this or any other country, remained supine during the early years of the new era. And, while our government was thus neglectful, every resource of the British government was applied, and every inducement offered, to promote the progress of ship-building in England.

These conditions prevailed all through the seventies and the first half of the eighties, until the government, resolving to have a new navy, appeared in the market as a customer.

Fortunately, during this dreary period of twelve or fifteen years of inanition, the *materiel* of our coasting traffic found need of renewal or increase, and the demand incident to this fact proved just about sufficient to nurse the spark of life in American ship-building.

Meantime English ship-building was progressing by leaps and bounds,—gaining almost absolute control of the North Atlantic, because, no matter where owned or under what flag sailed, almost all



U. S. CRUISER CHICAGO, 4500 TONS DISPLACEMENT.

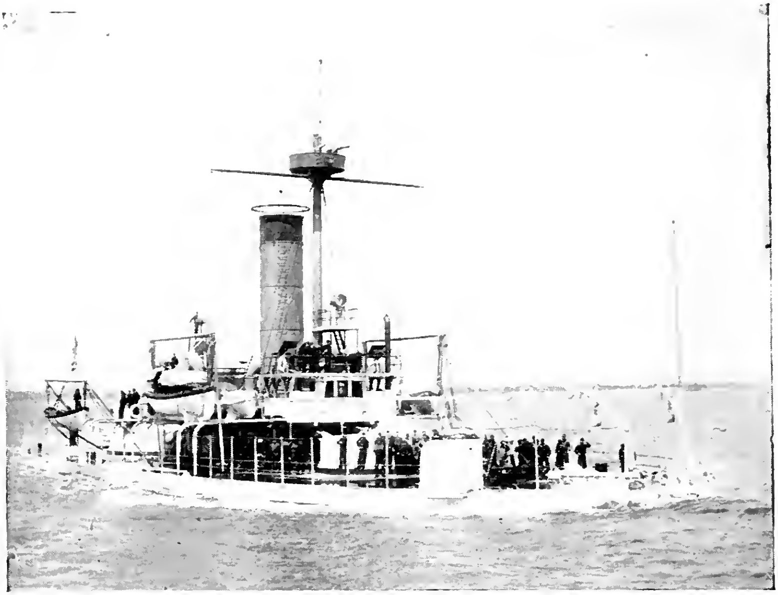
Length 325 ft., beam 48, draft 19. Built by Jno. Roach, Chester, Pa.

Copyright 1891, J. S. Johnston, N. Y.

ships in North Atlantic lines during this period were built in England. Subsidies were showered on English steamship lines, and English ship-yards and machine shops were glutted with contracts for construction of hulls and engines for the British navy.

About all that American statesmen attempted for American ship-building during this fitful epoch was the introduction of free ship bills in congress! No matter what theories prompted this proposed policy, its practical result would have been the employment of American resources to aid the English government in its efforts to promote English ship-building.

In 1883 the government began its new navy with the Chicago, Boston, Atlanta, and Dolphin. These were the first steel ships. As soon as their construction was attempted, the result of twelve years' neglect became apparent. Nobody knew whether this country could produce the necessary material or not, but the three leading ship-yards of the east submitted bids. Roach got the awards, but the sequel proved that he had discounted the unknown chances too heavily. The vessels, however, while not proving a source of profit, established a high standard for future construction, and are to-day useful and serviceable on the active list of the navy.



U. S. S. MIANTONOMOH, 3990 TONS DISPLACEMENT.
Length 259.6 ft., beam 55.10, draft 14.6. Built by Jno. Roach, Chester, Pa.
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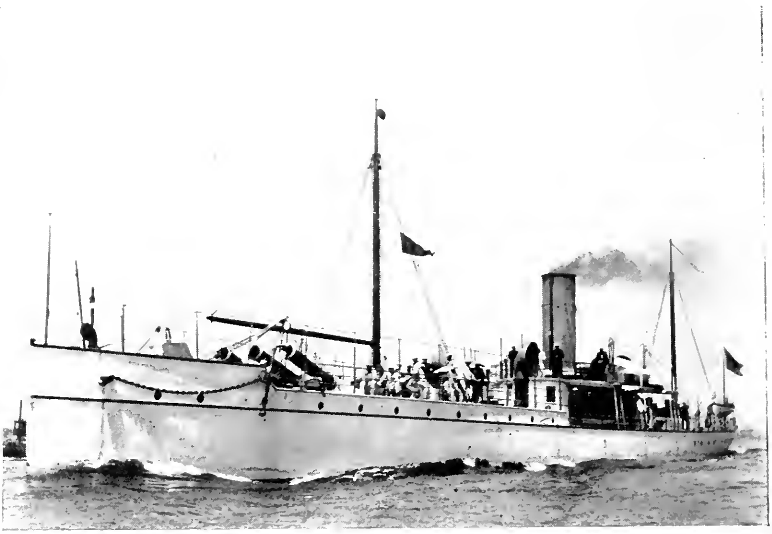

U. S. DYNAMITE CRUISER VESUVIUS, 930 TONS DISPLACEMENT.
Length 251 9 ft., beam 26.5, draft 10.7. Built by Wm. Cramp & Sons, Phila., Pa.
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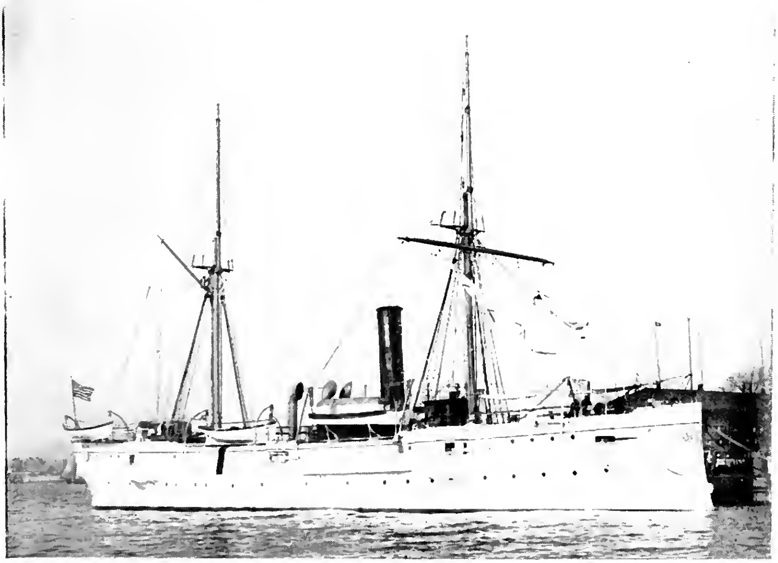

U. S. GUNBOAT MACHIAS, 1273 TONS DISPLACEMENT.
Length 204 ft., beam 32, draft 12.9. Built by Bath Iron Works, Bath, Me.
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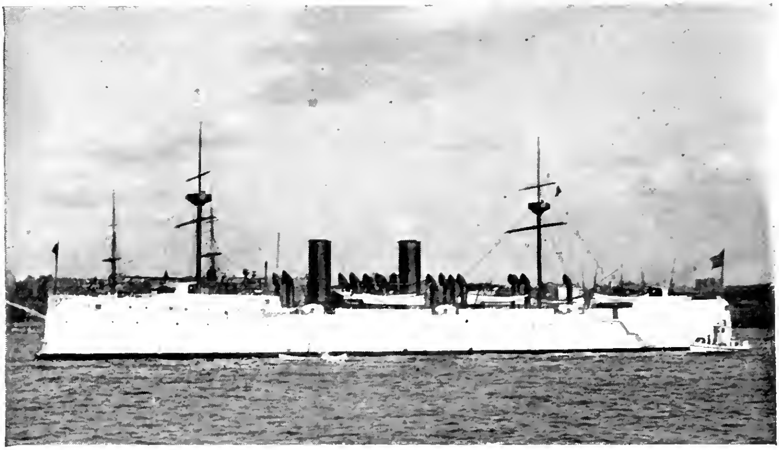
Whatever may have been its effect on Roach as an individual ship-builder, the general effect of this venture on American ship-building at large, and in the long run, was to give it a new lease of life, and inaugurate for it a new era of progress.

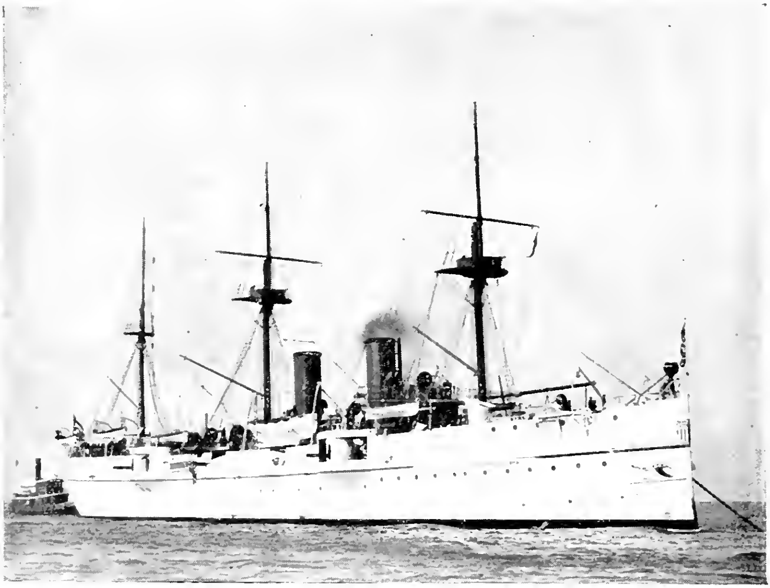
The reader will doubtless have perceived by this time that I am laying the foundation of an argument to the effect that ship-building, more than any other industry in this or any other country, is integral to the national welfare, prestige, and even political independence, and hence must always be, in the best and most patriotic sense, the *protégé* of the government. This I maintain strenuously, and I need only to call attention to the manifest results of the experience of other maritime nations to prove the truth of my premises and the soundness of my conclusions.

The government pursued its policy steadily; not indeed liberally, as compared with other great maritime powers, but still steadily and consecutively. What was the result?

By the time the third batch of ships was authorized, it appeared that American ship-building, with its contributory industries, which had groped in the dark in 1883, had by 1889 already outgrown the demand that created it. Never in the history of ship-building any-



U. S. CRUISER BALTIMORE, 4600 TONS DISPLACEMENT.
Length 327.6 ft., beam 48.8, draft 20.6. Built by Wm. Cramp & Sons, Phila., Pa.



U. S. CRUISER SAN FRANCISCO, 4083 TONS DISPLACEMENT.
Length 310 ft., beam 49.2, draft 18.9. Built by Union Iron Works, San Francisco, Cal.

where had such progress in every direction and in every branch been seen ; never had so small an impetus put in motion such giant forces Had bids for the construction of the New York and Olympia been invited five years sooner than they were, the contracts would have gone to England, or the ships remained in model or on tracing-paper. Had the bids for the construction of the first three battleships been invited in 1885 instead of 1890, American ship-building would have had a stroke of apoplexy due to surfeit. But five years of the progress of American ship-building, even under the meager encouragement offered, had made easy tasks of these battleships, and, instead of being surfeited, the industry already hungered for more.

The programme that eventuated in these three battle-ships was carefully thought out by Secretary B. F. Tracy, and he felt warranted in recommending the building of eight. Three were all that congress felt willing to authorize. It seems, in the light of the progress which is now a matter of history, that, had eight been authorized in 1890 instead of three, eight would now be in commission, or available for it, instead of three : and no one qualified to judge will gainsay that the capabilities of the ship-builders had been accurately gaged by the navy department.

It may be argued that the throwing of eight battle-ships on the market at that time would have acted as an over-stimulant to the development of the industry, with the consequent certain reaction.

U. S. BATTLE SHIP NEW YORK, 8480 TONS DISPLACEMENT.
Length 380.6 ft., beam 64.10, draft 23.10. Built by Wm. Cramp & Sons, Phila., Pa.
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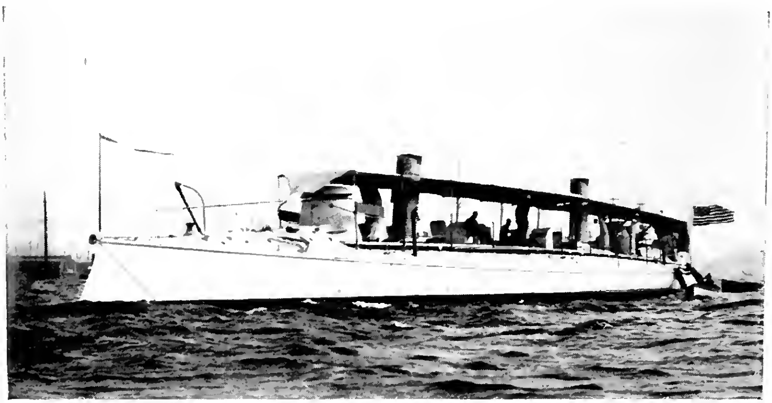
But I am neither offering or combatting purely speculative arguments. I am dealing only with accomplished facts and known performances.

If we turn elsewhere for illustration or example, we shall find that twice, since we began our new navy, has England launched on her ship-building market single programmes of new construction exceeding in displacement and cost our entire fleet.

Before we began our new navy, Great Britain had the Bellerophon as flag-ship of her North Atlantic and West Indian Squadron, old even then, but more than a match for any vessel we possessed. But, as we have launched ship after ship, the English vessels on this station have been keeping pace with us in strength, and the successor to the Bellerophon, the splendid armored cruiser, Blake, has been succeeded by a battle-ship, since our Indiana was commissioned.



U. S. TORPEDO BOAT CUSHING, 116 TONS DISPLACEMENT.

Length 138.9 ft., beam 14.10, draft 5.3. Built by Herreshoff Mfg. Co., Bristol, R. I.

The inference is obvious. What we have seen and what we know requires no argument to establish; and we have seen and we know that the policy of the new navy, more than all other causes combined, has raised American ship-building from its struggle for existence a decade and a half ago to its exultant eminence of to-day.

The believer in free ships, however, says: Very well; admitting all these plain facts as far as the navy is concerned, what have they to do with commercial ship-building, or with the employment of American-built ships in peaceful traffic? The answer is that the New York, Columbia, Minneapolis, Indiana, Massachusetts, Brooklyn, and Iowa made the St. Louis and St. Paul possible; and they also made possible any needed number of St. Louises and St. Pauls, or better ships, in

U. S. BATTLE SHIP COLUMBIA, 7744 TONS DISPLACEMENT.
Length 412 ft., beam 58, draft 24. Built by Wm. Cramp & Sons, Phila., Pa.
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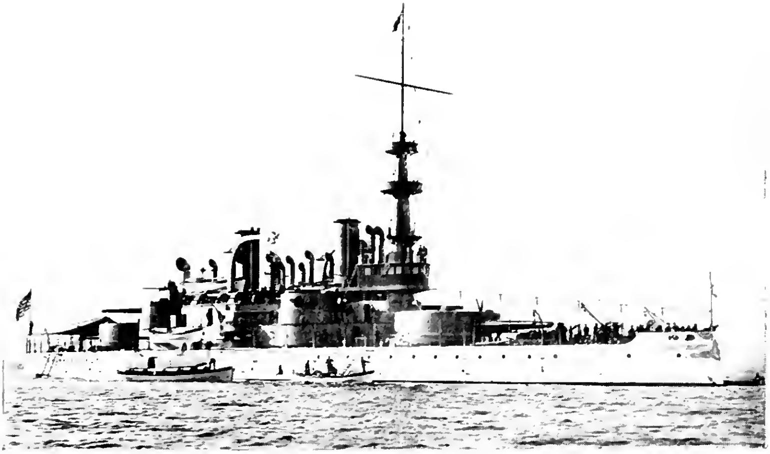

U. S. BATTLE SHIP INDIANA, 10,288 TONS DISPLACEMENT.
Length 348 ft., beam 69.3, draft 24. Built by Wm. Cramp & Sons, Phila., Pa.
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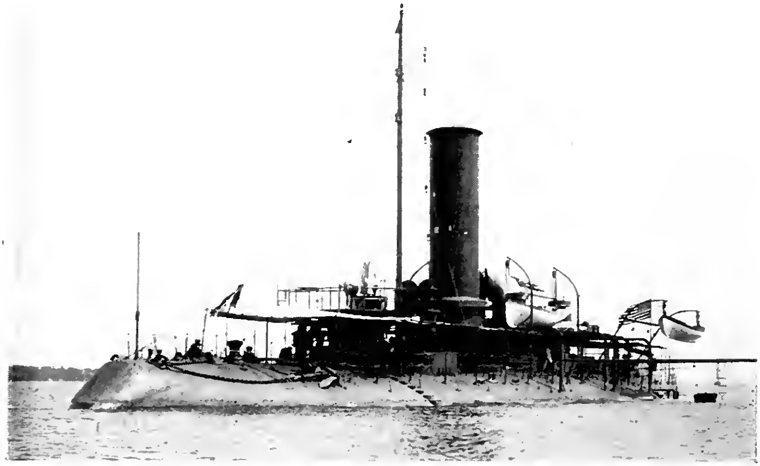

U. S. RAM KATAHDIN, 2155 TONS DISPLACEMENT.
Length 250.9 ft., beam 43.5. draft 15. Built by Bath Iron Works, Bath, Me.
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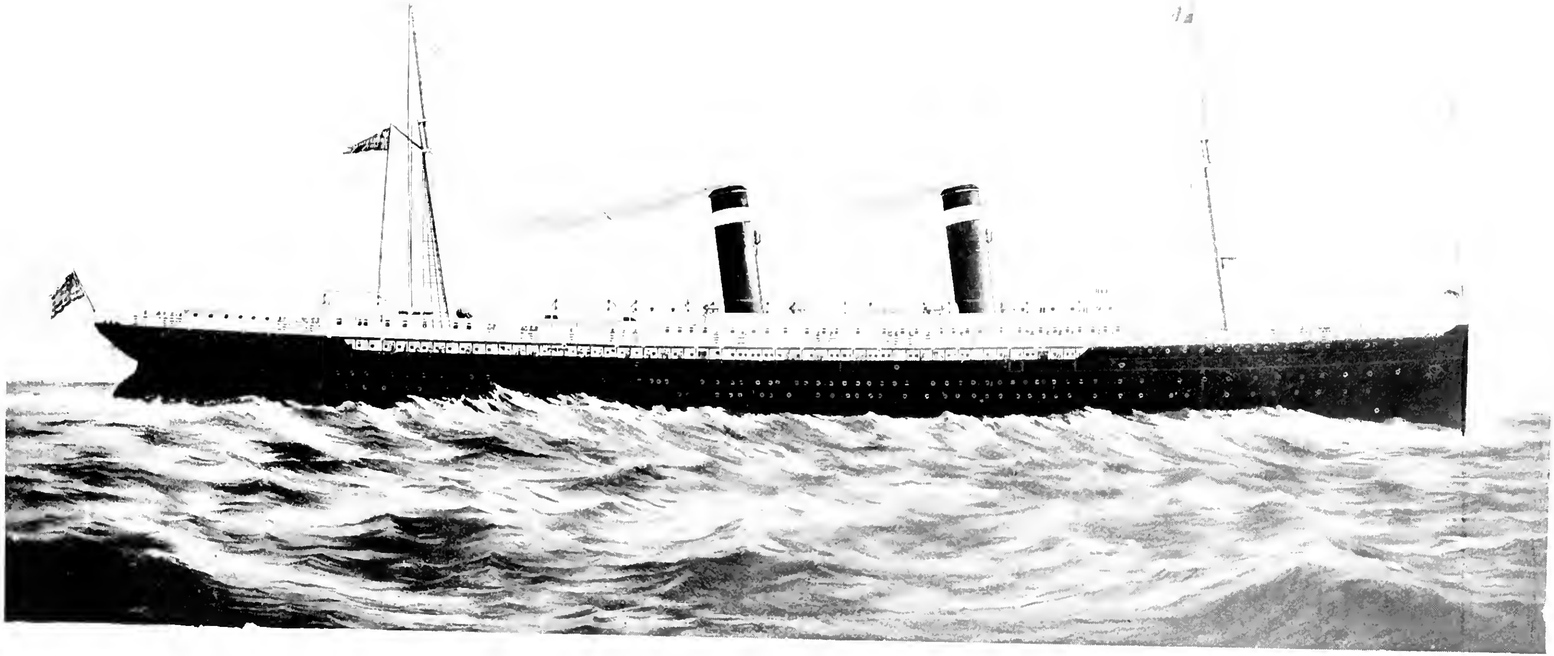
the future. In a word, our policy of the new navy broke the back of England's ship-building monopoly, and broke it beyond cure.

If not, why are Japanese cruisers building in American ship-yards?

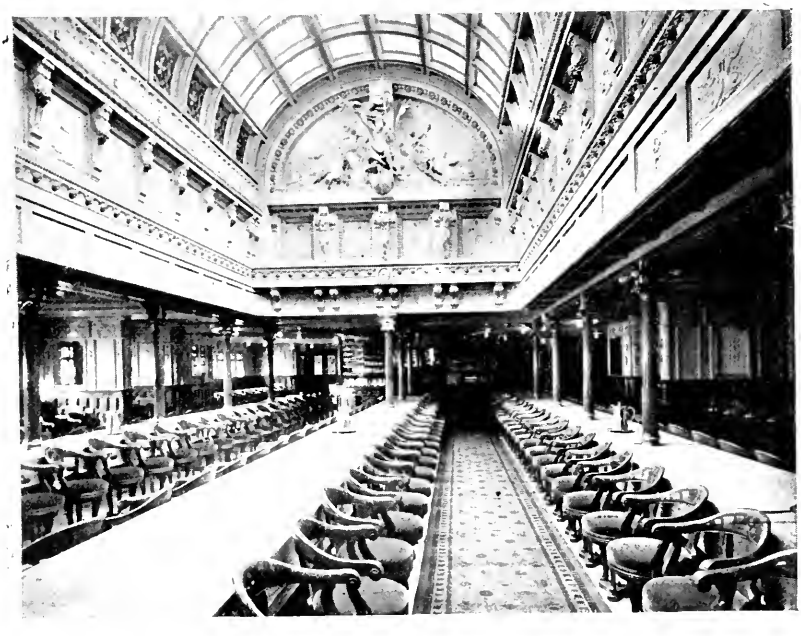
Mr. Charles H. Cramp, in an article on the sea power of the United States, says: "We have made great and rapid progress during eight years of naval construction, but we have not yet rebuilt our navy. In fact, about all we can reasonably say is that we have conclusively demonstrated our domestic capacity to rebuild it."

I have heard it said that, no matter what our progress in ship-building has been, we had to begin with English plans. Unquestionably English plans were procured at the start: so were French plans. But they were used for reference, not for imitation. No naval ship has been built exactly after any foreign plan. They have all been modified more or less. In fact, the object in having the foreign plans before us was to see what should be avoided as well as adopted, and in some cases the former desideratum proved the more important of the two. Foreign plans are as much sought after now as they were at the beginning, and for the same reason. But, withal, our best ships—the New York; the Columbia and Minneapolis; the Indiana class of battleships, the Iowa and Brooklyn; and the Kearsarge and Kentucky

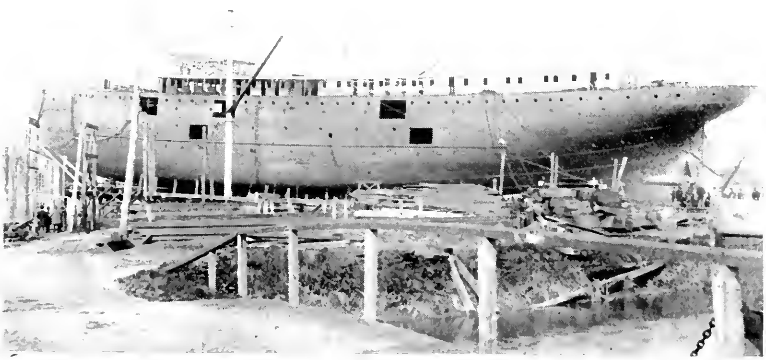


THE AMERICAN LINE STEAMSHIP ST. LOUIS, 11,629 TONS.

Length 534 ft., beam 63, depth 42. 20,000 horse power. Built by Wm. Cramp & Sons, Phila., Pa.



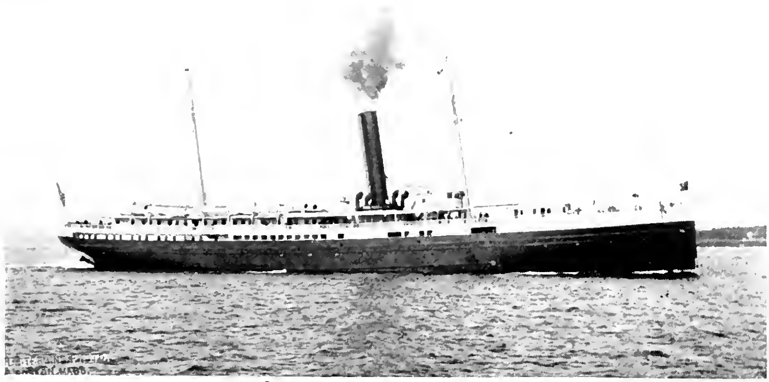
THE MAIN SALOON AND A PRIVATE SUITE, S.S. ST. LOUIS.



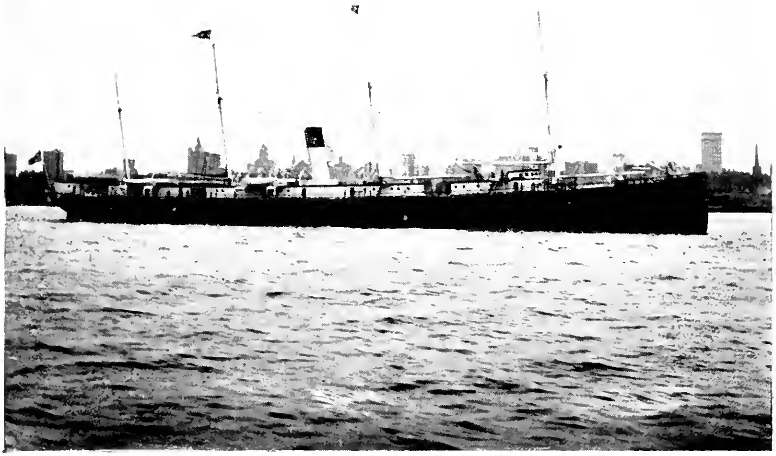
STR. HOWARD, 1757 TONS, MERCHANTS' & MINERS' TRANSPORTATION CO.
Length 270 ft., breadth 42, depth 26. Built by Harlan & Hollingsworth, Wilmington, Del.

—are distinctively American from keel to fighting tops,—hulls, machinery, and all. So also the Olympia, and most of our smaller ships.

I trust that I have made at least one point clear,—namely, that the vast progress in American ship-building since 1883 is due to the stimulus afforded by the naval policy of the government; that, in its ab-



STR. YORKTOWN, 2126 TONS. OLD DOMINION LINE.
Length 298.5 ft., breadth 40, depth 34. Built by Delaware River I. S. B. & E. Co., Chester, Pa.

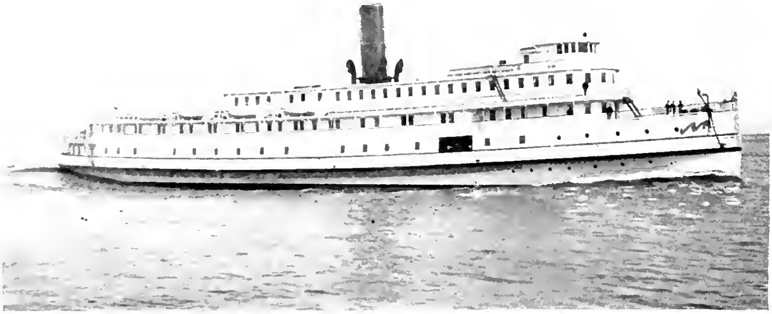


STR. EL NORTE, 2901 TONS. MORGAN LINE, SOUTHERN PACIFIC CO.

Length 380.5 ft., breadth 48, depth 23.9. Built by Newport News S B & D D. Co , Newport News, Va.

CAR-FERRY STEAMER MARYLAND.

Built by Harlan & Hollingsworth, Wilmington, Del.

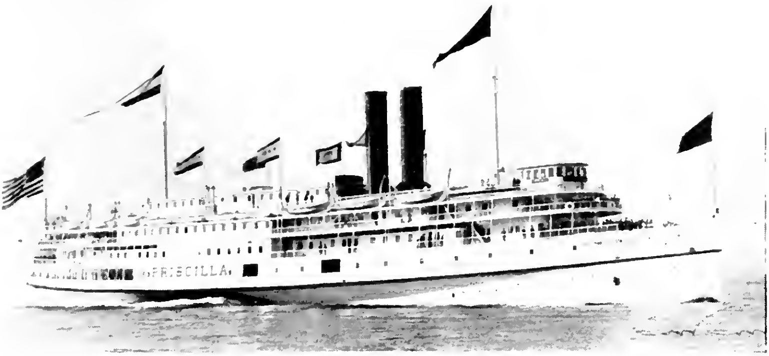


STR. MAINE, PROVIDENCE & STONINGTON S. S. CO.

Length 302 ft., breadth 44, depth 12.5. Built by Harlan & Hollingsworth, Wilmington, Del.

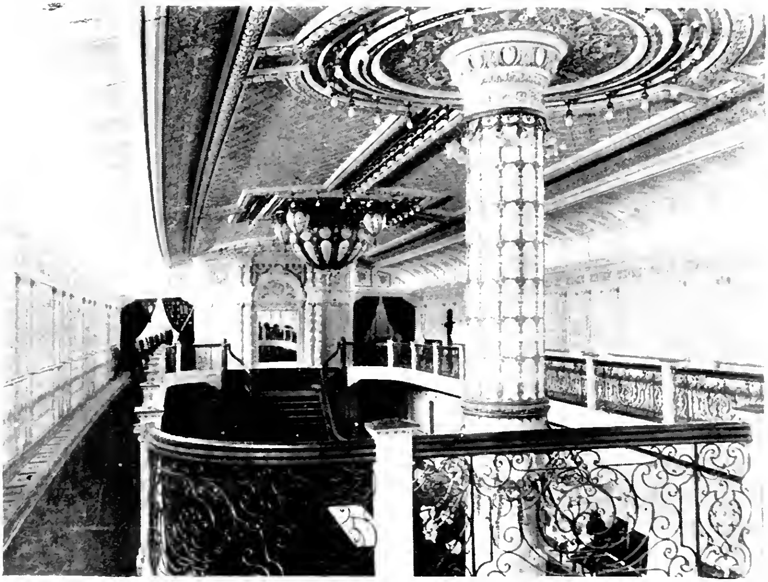
sence, and under impulse of the normal commercial demand alone, no such progress would have been possible; in fact, little or none at all in comparison with that observed elsewhere.

At this point I am likely to be interrupted by some western friend with the query: Why, then, has ship-building made such progress on the Great Lakes, where no part of the new navy has been built, and



STR. PRISCILLA, 2673 TONS. FALL RIVER LINE.

Length 425.8 ft., breadth 52.3, depth 18.3. Built by Delaware River I. S. B. & E. Co., Chester, Pa.



GRAND SALOON, STEAMER PRISCILLA.

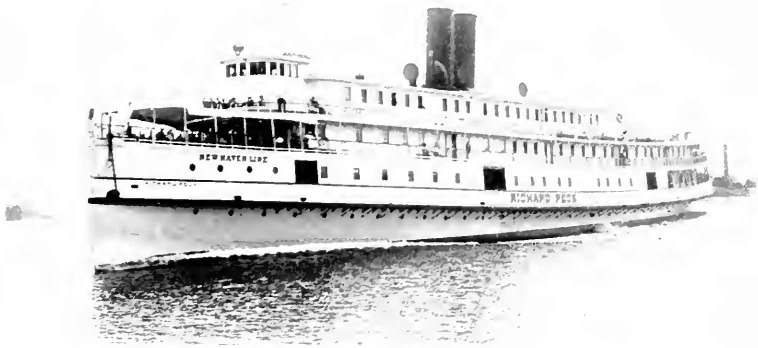
MAIN COMPANION WAY, STEAMER MAINE.

where the stimulus of governmental policy has not been felt? Such a query betrays ignorance of, or indifference to, the actual state of things. As a matter of fact the fostering power of governmental policy in favor of Lake shipping and ship-building has been exhausted.

First, the Lake shipping enjoys the full and undisturbed benefit of the coast-trade laws.

Second, the terrific foreign competition that throws a constant shadow over the ocean is wholly absent from the Lakes.

Third, in the matter of harbor improvement and the bettering of waterways, the government has done everything for the Lakes that acute ingenuity could devise or dauntless means supply.



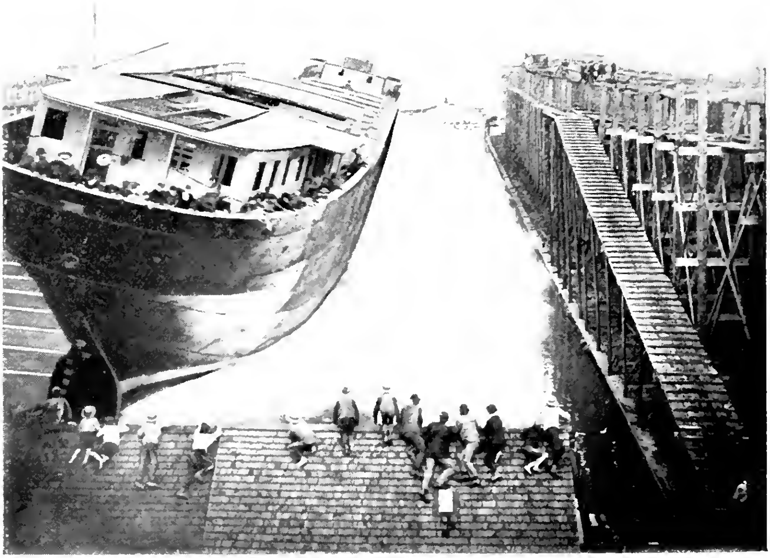
STR. RICHARD PECK, 1819 TONS. NEW HAVEN LINE.

Length 300 ft., breadth 48, depth 17.9. Built by Harlan & Hollingsworth, Wilmington, Del.

Fourth, the public opinion of the whole region tributary to the Lakes demands imperatively that they be brought to, and maintained in, a condition suitable to complete efficiency as a check on the trunk railway lines.

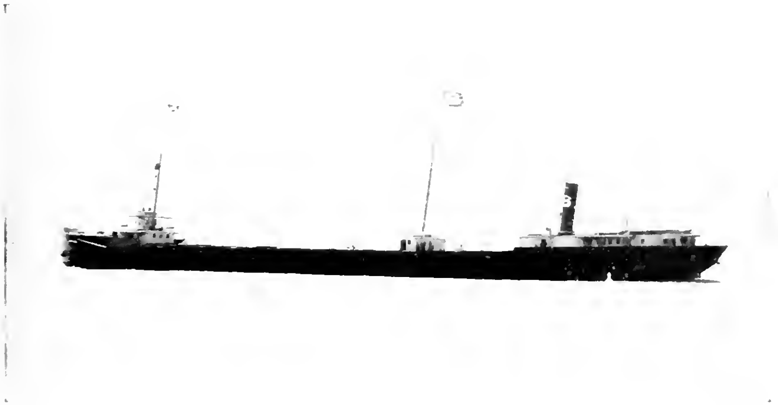
From these facts it will be at once perceived that there can be no common plane on which to institute comparison between shipping and ship building on the Lakes and on the two great salt-water coasts.

There is another prime consideration germane to the question of stimulus involved in the naval policy of the government,—the fact that, notwithstanding the feeble state of contributory industries at the outset, and the consequent necessity of initial development, the tests



LAUNCH OF THE STEAMER SIR WILLIAM FAIRBAIRN.
Built 1896 by the Detroit Dry Dock Co., Detroit, Mich.

HUDSON RIVER STEAMER ADIRONDACK, PEOPLE'S LINE.



LAKE FREIGHTER SIR WILLIAM FAIRBAIRN.

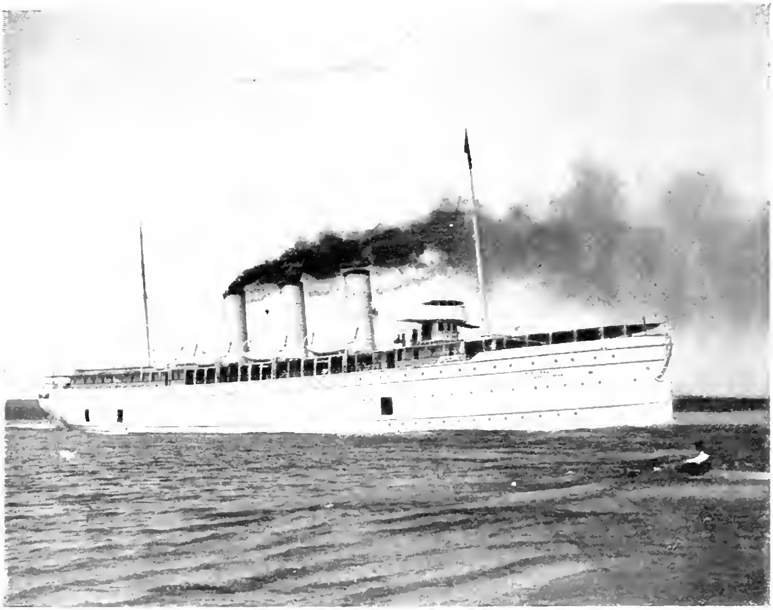
Built by Detroit Dry Dock Co., Detroit, Mich.

prescribed for physical qualities of material used in our ships have constantly exceeded in severity and precision the tests of any other country.

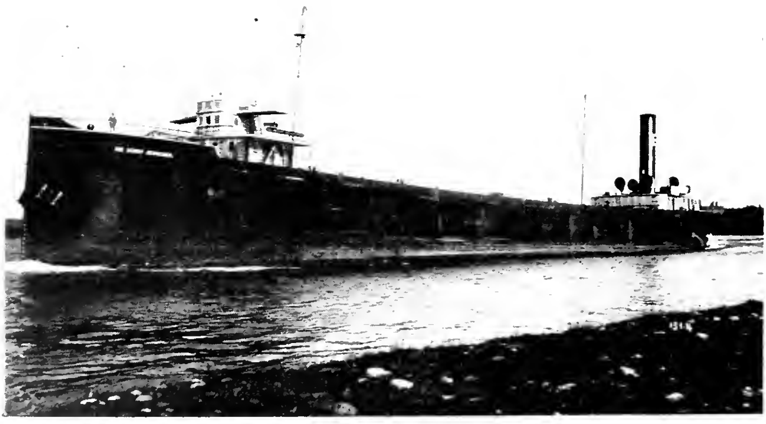
These requirements, unprecedented as they were at the time when they were prescribed, have been met and overcome. and to-day we can say with pride that, as the gratifying result of the unusual efforts thus induced among American manufacturers, the steel made for the navy and merchant vessels of the United States is far superior to that of any other nation. This is a result of value extending far beyond the single province of marine architecture.

THE MC DOUGALL FREIGHT WHALEBACK.

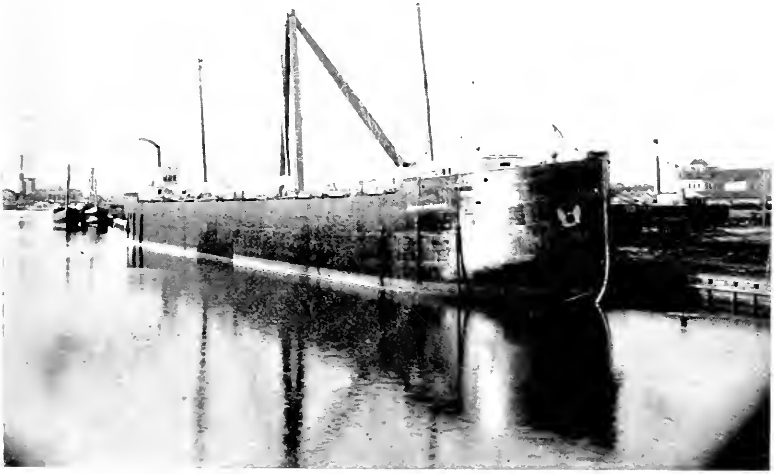
Built by American Steel Barge Co., West Superior, Wis.



STR. NORTH LAND, 4244 TONS. NORTHERN S. S. CO.
Length 383 feet, breadth 44, depth 26. Built by Globe Iron Works, Cleveland, O.



STR. SIR HENRY BESSEMER.
A Typical Lake Ore-Carrier.



TOWING BARGE OR SCHOONER NIAGARA.

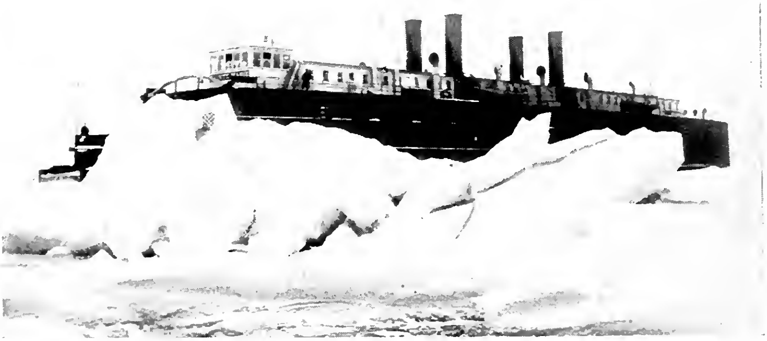
Built by Chicago Ship-Building Co., Chicago, Ill.

The total merchant marine of the United States for certain years is shown in the following table :

Year.	Number of vessels.	Tonnage.
1870	28,998	4,246,507
1880	24,712	4,068,034
1890	23,467	4,424,497
1895	23,240	4,635,960
1896	22,908	4,703,880

The tonnage built during certain years is as follows, the year ending on the 30th of June of the respective years :

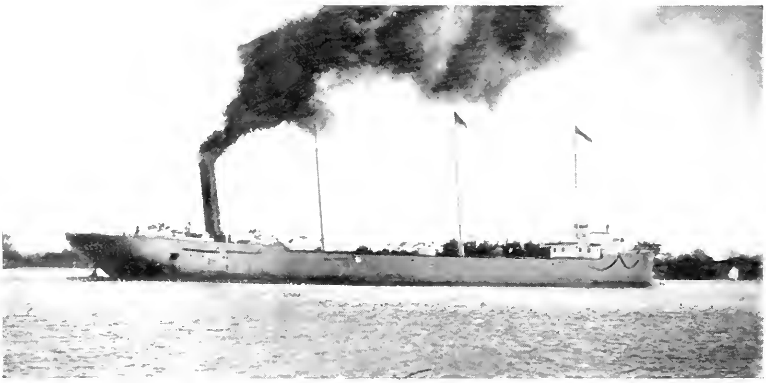
Year.	On seaboard.	Mississippi River and tributaries.	Great Lakes.	Total.
1870	182,836	56,859	37,258	276,953
1880	101,720	32,791	22,899	157,410
1885	121,010	11,220	26,826	159,056
1890	169,091	16,506	108,526	294,123
1891	237,462	19,984	111,856	369,302
1892	138,863	14,801	45,969	199,633
1893	102,830	9,538	99,271	211,639
1894	80,099	9,111	41,985	131,195
1895	67,127	8,122	36,353	111,602
1896	102,544	15,771	108,782	227,097



CAR FERRY SAINTE MARIE, 1357 TONS, IN 27 INCH ICE.
Length 502 feet, breadth 51.6, depth 24. Built by Detroit Dry Dock Co.

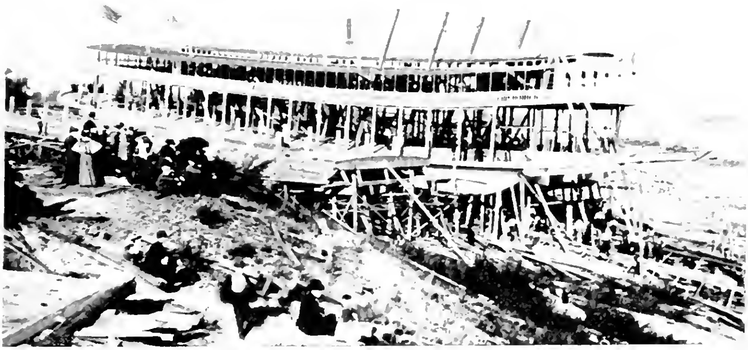
The value of the shipbuilding industry is shown below :

Year.	Capital invested in shipyards.	Number of employees.	Gross income of yards
1870	$ 9,102,335	11,063	$17,910,328
1880	20,979,874	21,345	36,800,327
1890	53,393,074	25,934	40,342,115

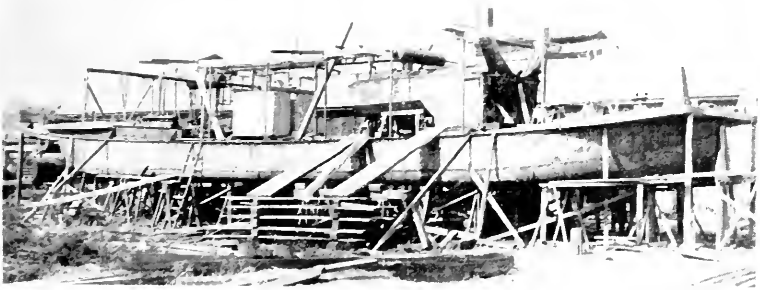


STR. ZENITH CITY. A TYPICAL LAKE FREIGHTER.
Built by Chicago Ship-Building Co., 1895.

OHIO RIVER PACKET CITY OF LOUISVILLE, 1681 TONS, ON THE STOCKS.
Length 301 feet, breadth 42, depth 7.

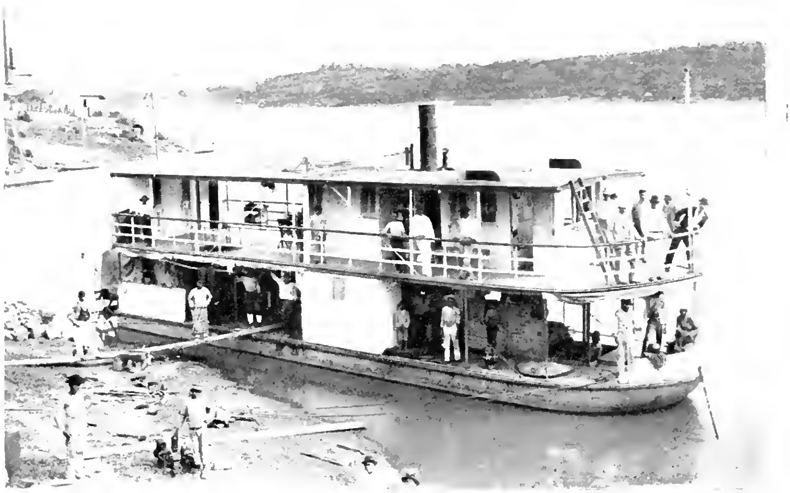


STEAMER BLUFF CITY, JUST BEFORE LAUNCHING.



A STEEL STEAMER FOR SHIPMENT TO MEXICO.

WESTERN RIVER VESSELS. HOWARD'S SHIPYARDS, JEFFERSONVILLE, IND.



STR. CAURA IN SOUTH AMERICAN WATERS.

Built at Crescent Shipyards. Elizabethport, N. J.

MC DOUGALL PASSENGER WHALEBACK CHRISTOPHER COLUMBUS, 1511 TONS.

Length 362 feet, breadth 42, depth 24. Built by American Steel Barge Co., West Superior, Wis.

On June 30, 1896, there were 1179 yachts, of an aggregate tonnage of 44,022, belonging to citizens of the United States.

The total value of all the vessels of the United States, including those belonging to the government is about $300,000,000.

So much for the progress of American ship-building in recent years. Briefly and cursorily I have outlined its causes, and indicated some of the difficulties and obstacles in spite of which it has been achieved. As it stands, it fills a splendid page in our national history, and the men who have been identified with it in any capacity may rest secure in the patriotic consciousness of having served their country well.

Coming now to the second division of my theme, I repeat my remark at the outset that the promise in American ship-building at this time is quite as speculative as the possible progress was when progress began.

Taking up the naval prospect first, it may be granted that, according to the average of qualified opinion, our modern navy, including the latest ships just contracted for, is about half-built or building. At all events, at least as much remains to be done as has been done, in point of number, tonnage, and cost of ships, before our establishment can reach the minimum status of readiness for war in time of peace. In what manner or to what extent from year to year the remaining half of the necessary programme will be executed, no one can foresee; but the fact that the destinies of American ship-building still hang largely on the future naval policy is as indisputable now as it was thirteen and a half years ago. If the policy proceeds with system and regularity, promise will continue to develop into progress, as heretofore. But any serious break in, or temporary abandonment of, the increase of the navy programme would be quickly and disastrously felt by American ship-builders; and not only by them, but likewise, in their train, by the almost innumerable throng of contributory or dependent industries.

Here it seems proper to devote a word to the contributory industries. No one will dispute the assertion that a country is better off with such establishments as the Bethlehem Iron Works, Carbon, Midvale, Carnegie's, Paxton's, the Illinois Steel Works, etc., than without them. The progress of these industries during the epoch of naval reconstruction has kept even pace with that of ship-building. They have had, indeed, other markets, but the market which, above all others, has challenged their enterprise, invoked their ambition, and stimulated their advancement has been that offered by ship- and engine-building. Any blow disastrous to the latter would be equally and instantly destructive to them. A majority of one vote in congress against further prosecution of the prevailing naval policy would stop the 14,000-ton forging press at Bethlehem, silence the great rolls in Pittsburg, Cleveland, and Chicago, and check the hum of innumerable lesser wheels, as well as make grass grow in ship-yards.

The promise in American ship-building at the commercial end is by no means secure. More than one ship-yard in the United States could be named which is amply capable of meeting the whole probable commercial demand for new ships for the next ten years under existing conditions, so far as sea-going ships of, say, 2,000 tons register and upwards are concerned, exclusive, of course, of the Lakes. This assertion may startle men not intimately familiar with the state of the industry, but every ship-builder will accept it as the plainest of truisms.

It may be inferred from this that I consider the ship-building industry in America overdeveloped from the commercial point of view. Such inference would be wrong. The existing state of development as to facilities is no more than has been required—I might say, forced—by the demands of the navy. It is, therefore, normal and necessary. Hence the fault, if any, is not in overdevelopment of ship-building facilities. On the contrary, it is in the underdevelopment of commercial demand; and that underdevelopment is due to causes which can be removed only by betterment of the national policy in the direction of the merchant marine.

It must be borne in mind that we are dealing, so far as the ocean-carrying trade is concerned, with the fostered, encouraged, or subsidized merchant marines of England, France, Germany, and Japan, and, to a less, but still troublesome, extent, with those of the Scandinavian States, and Holland, whose cheaper labor and cheaper fare amount in the competition to more than a moderate subsidy. In this strife the American merchant marine is confronted with the problems of high wages and costly fare, without compensating conditions of any kind. A so-called subsidy law is in force; but it is so restricted in its application that but two steamship lines can derive any assistance from it, and even this assistance becomes pitiful when compared with the obstructive conditions that they have to surmount. In a word, the state of the American merchant marine is not calculated to cause any considerable or sustained demand for new construction in the sea-going classes, and hence, as a matter of course, there is little in that direction to offer promise to the ship-building of the future. This may not be a pleasant, and certainly is not an exhilarating, theme for a ship-builder, and it will probably add nothing to the sum total of the prevailing aspiration for a renewal of prosperity. Not until the rehabilitation of the American over-sea commerce is made a fixed national policy, elevated above all questions of party expediency, in the carrying-out of which our diplomats and legislators shall be in hearty accord, can a healthy demand be created for ocean-going ships. Almost from the foundation of the republic we have been piling up treaties with almost every nation, the effect of which has been, and is, to reduce our merchant marine, alone of all our great national interests, to an even footing with the cheap-labor nations of the old world. The trouble lies more in our diplomacy than in our legislation. It seems that we are full of discrimination in favor of any and every one of our great industries, except that of ocean traffic. But, whenever it is proposed to discriminate in favor of that, the archives of the department of State open, and belch forth vetoes in the shape of forgotten treaties, in every one of which our birthright on the sea has been bartered away. In population, judged by the standard of average enlightenment; in area, judged by the standard of available productivity of soil; in wealth, judged by the standard of active capital and mobile resources,—we are undoubtedly the greatest nation on the earth; but the instant we touch salt water in the carrying-trade, our treaties throw us upon the tender mercies of the humblest, as well as the proudest, States of Europe. The intelligent application of the proverb, "charity begins at home," would mean much to our commercial interests on the ocean.

From these deductions it is apparent that the existing state of our over-sea merchant marine is due to deep-seated and fundamental causes which cannot be adequately dispelled by any mere "Be it enacted." The conditions which confront us are epochal, not accidental. We have been supine, while others have been active; we have let our interests take care of themselves, while others have taken care of theirs; and we are now confronted with the inexorable result of our short-sighted and unpatriotic folly.

The task of national rescue from these sad and humiliating conditions is an herculean one. Whether or not our statecraft and diplomacy of the future will prove equal to it is something beyond my ken. But it is perfectly plain that persistence in the aimless, purposeless, and nerveless policies of the past not only will not effect the desired rescue, but must deepen the degradation.

We can find encouragement in one most important direction, despite this gloomy outlook. Causes already delineated have promoted the ship-building industry to a point where, quality of output being duly considered, it can compete on even terms with any and all comers. The disparity in first cost between American- and British-built ships of like classes has been so nearly eliminated by our recent phenomenal progress in the art, notwithstanding our higher wages, that it has ceased to be an important factor in the situation. Merchant and steamship companies can now, all things considered, procure American-built ships as economically as ships of English build. This, of course, refers to the higher classifications. Hence the American ship-builder is ready to do his share towards resurrection of our sea-going merchant marine on the most favorable footing. But, as yet, the disparity between this country and England in the matter of cost of operating ships of like classes exists in full force,—in sufficient force to be practically prohibitory. For this reason, and for this alone, the facilities of the American ship-builder are not to any considerable extent, or with any encouraging continuity, called into requisition by the American ship-owner. This is not because the American ship-owner does not desire new ships, but because, under existing conditions of competition with rivals receiving substantial aid from their respective countries, he could not operate them profitably if he had them.

Thus the reader will perceive that, no matter from what point of view the situation is surveyed, or no matter at what admitted point of fact the train of reasoning may begin, the conclusion arrived at is always the same,—namely, that the future of American ship-building in any large sense depends upon the future of American traffic over sea; and that the future of over-sea traffic is wholly in the hands of our national statecraft and diplomacy.

So, while viewing the progress of American ship-building with exultant pride, let us look to its promise with fervent hope.

THE PROSPECTIVE RESUMPTION OF MINING ACTIVITY.

By David T. Day.

THE quantity and value of the mineral products of the United States form a good barometer of industrial prosperity. Mineral industries are more directly affected by commercial changes than almost any others, since the crude products of the mines serve as the starting-point for most manufacturing enterprises. Any industrial expansion must be anticipated by a correspondingly increased supply of the crude minerals necessarily involved. This is a different condition of affairs from that prevalent only a few years ago, and, in the minds of many, the mineral product still consists of whatever the prospector happens to discover and mine. To these mining means speculation,—nothing more. Perhaps even the majority of business men fail to recognize that there is less speculation about the coal product than in any agricultural crop, the volume of which is affected by every change in the weather,— accidents to which the miner is practically indifferent.

Formerly we mined what we could of our mineral wants, and imported the rest. Now, on the contrary, the United States is the greatest mineral producer, furnishing nearly two thirds of the world's petroleum, more than one half of all its copper, one third of the pig-iron and coal and nearly one fourth of the gold, iron-ore, and zinc. We export far greater values than we import. Not only are our mines well equipped, but the resources known, though undeveloped, give assurance of continued mineral supplies, even without the prospecting which, aided by more exact geological exploration, is constantly becoming more effective. One well-recognized condition necessary for mining prosperity is to find a market for the continually-growing supply. Full activity for the enormous mining plants of the country means great prosperity. But, after several years of declining industrial activity, a glance over the field shows a great aggregate of capital invested in idle mines and their accessories. That this is a serious, even critical, condition for the capital involved will be appreciated by considering the rapidity with which an idle mining plant depreciates. Mining machinery is rendered worthless more rapidly than that of a well-protected factory. Frequently the mine-water is so acid as to quickly corrode metals to a worthless condition, and in the deeper mines the encroachment of water alone frequently amounts to more than the mineral is worth, and then a shut-down means abandonment.

The table given on a following page, showing the idle coal mines of the United States, is typical of the whole mining industry. With this condition of much idle capital waiting for an increased market, it is interesting, with the advent of a widely-announced era of general prosperity, to show in what channel the mining revival will be most evident and most important. That even the mere announcement of approaching prosperity will have this stimulating effect is undoubted. Usually a considerable period of time is required for the development work necessary before new mines can increase the mineral output, and the new demand from more active industries must be supplied from accumulated stocks with a corresponding appreciation of prices. But at present there is unusual ability on the part of idle mines, and still more on the part of those not working up to full capacity, to respond promptly to additional demand, and, on the other hand, the long-continued depression has discouraged the accumulation of stocks. The response from the mines will be unusually prompt. Whether for good or disaster, the year 1897 will witness the greatest experiment ever made as to the productive capacity of the mines. Increased prosperity must enter into all business calculation for 1897, for its demand for raw materials is severe and immediate, and must be anticipated.

To the average producer accustomed to forecast his market the meaning of the starting of three hundred industrial plants between election day and November 10, as shown by the New York *Commercial Bulletin*, is evident. For example, this prospective increased demand for raw material led at once to such activity in marketing the Lake Superior iron ores that lake freight rates have advanced, in spite of the accumulated supplies at Cleveland and other lower lake ports.

Among the plants which started into activity with the election it is significant that it was a blast furnace which Major McKinley selected as typical of productive industry, and, in spite of the preparation required for blowing in a furnace, on November 5, two days after the election, one was ready to kindle into activity at Tonawanda, New York, by an electric spark from Canton. But this was not an accidental condition. Many other furnaces and mills for iron and steel in Pennsylvania and the Ohio valleys were ready, and have since started. The president-elect selected the industry which has most promptly responded to the prospect for better times. The conservative tendency of the past three years is nowhere more evident than in the restricted use of iron and steel for all purposes. Some of these industries may be slow to respond,—the steel-rail industry, for example, since no considerable extension of railway mileage is yet in sight,—but for structural materials for large buildings, the erection of which has been greatly retarded by dull times, and for much-needed railway equipment, rolling stock, and bridge-work, the demand will be great. Mr. James M. Swank states that we may expect a decrease in the total product of pig iron for the year just closing. But this will bring out more sharply the contrast with the decided increase which, he admits, we may expect in 1897. It is difficult to guess at the exact measure of increase, but the figures for 1897 should come fully up to the record-making figures of 1895, and may go beyond them. While capital will not flow freely into new railway enterprises, as in other years, there is no reason to believe that there will be any cessation in the demand of steel for ship-building and for a thousand other uses. Prices must necessarily be higher in 1897 than to-day, but there will be no great advance, and there will be no boom, because of our very large capacity for the production of all forms of iron and steel.

Copper is another metal quick to respond to general trade activity. When we consider the recent advances in electrical development at Niagara, and reflect that this was impracticable without increasing the use of copper, and further the enormous amount of recent electric installation in mining plants alone, to say nothing of the greatest use in new trolley systems, it is evident that the draft on the copper market will be unusually large in the next twelve months. The experience of the present year has also developed an important export outlet for copper.

Mr. Kirchhoff, editor of the *Iron Age*, writes to me that the outlook for the copper industry is very favorable, since it is considered that there will be added to the extraordinary demand in Europe a rate of consumption in the United States more nearly approaching the normal. The amount of copper which has gone into the hands of consumers has been very large in Europe. Thus statistics show that the deliveries in England and France were 114,744 gross tons during the first ten months of 1896, as compared with 85,078 gross tons during the corresponding period of 1895. The visible supply in Liverpool, Swansea, London, and Havre was only 35,441 gross tons on November 1, 1896, against 50,250 tons on November 1, 1895. It is well known, although the exact figures are not available, that Germany, Russia, and Austria have taken an unusual amount of copper during the current year.

By far the heaviest contributor to the increased supplies in Europe have been the United States. During the first ten months of 1896 the exports from this country were 100,489 gross tons of copper,—a rate of 120,000 tons per annum. It is known that this quantity will be shipped this year, because the metal has been sold and freight-room has been engaged. In 1895,—until then a banner year in the export movement,—the total shipments amounted to 64,722 gross tons. While in this direction there has been an enormous expansion, there has been a sharp decline in the home-consumption of copper. Leaving out of consideration the question of stocks, concerning which there are no reliable data whatever, the production figures collected by Mr. John Stanton furnish adequate data. During the first ten months of this year the home-production was 169,910 gross tons,—a rate of 200,000 tons per annum. Since the exports will amount to 120,000 tons, this leaves about 80,000 tons as the apparent home-consumption, ignoring stocks.

In 1895 the total production was 171,197 tons, of which 64,722 tons were exported, leaving the home-consumption at 106,475 tons. This is a decline of about 25,000 tons. With the restoration of confidence and a general moderate revival in business, leading to investment in electrical equipment, the home requirements ought, in 1897, to reach the 1895 standard, or even surpass it.

Since we know that the leading European industries are engaged even now for the whole of 1897, and some of them for 1898, it seems probable that larger quantities of copper will be needed, and that this must be coupled with a rise in prices. The latter are now low, so that there is room for a considerable rise before reaching prices likely to check consumption.

The general sympathetic effect of the expansion of one metal trade upon others of the same class will of itself suggest an expansion for lead, zinc, tin, antimony, and other minor metals during the year to come. Unfortunately we are in a condition only to lose by any prosperity which may come to the position of the tin-supply ; for there is no prospect of our being able to compete with the far richer tin deposits and much cheaper labor of East India. But the beneficial effect of prosperity to the tinplate trade will not only be felt by the vigorous, though new, tinplate manufacture here, but will be evinced by the demand for the necessary black plates, which make the most important raw material for tinplates.

Associated with the expansion of our steel industry comes greater demand for manganese and nickel, and even for chromium and tungsten, but of greater importance is the increased demand for limestone and for fuels, which must increase proportionately with the iron and steel.

The present condition of the idle mines in the coal industry is an interesting one, and well shown by the accompanying table prepared by Mr. E. W. Parker :

NUMBER OF COAL MINES IDLE IN 1895, WITH LATEST AMOUNT OF PRODUCTION REPORTED.

STATES.	Number of mines idle.	Probable production, if active.	Average product per mine.
		Tons.	Tons.
Alabama	8	71,740	8,968
California	2	6,080	3,040
Colorado	10	174,633	17,463
Indiana	7	125.496	17,928
Iowa	12	72,277	6,026
Kansas	12	78,804	6,567
Kentucky	4	109,030	27,257
Maryland	1	17,613	17,613
Missouri	24	79,915	3,313
Montana	7	79,011	11,287
New Mexico	2	280	140
Ohio	29	572,353	19,736
Pennsylvania	54	919,524	17,028
Tennessee	2	11,279	5,639
Utah	1	1,680	1,680
Virginia	6	19,061	3,177
Washington	3	31,453	10,484
West Virginia	14	207,715	14,837
Wyoming	8	6,140	768
Totals and average.	206	2,483,684	12,154

Estimating the idle mines in Illinois and those in in the anthracite region of Pennyslvania, we have more than two hundred and fifty entirely idle coal mines, which have in past years actually produced more than three million tons of coal. But to stop here would represent the industry in a better condition than the facts justify. A much more significant feature is furnished by the mines running on part time. Partial idleness, or even a very slight reduction in the working-force of one of our large mines, affects a State's product more seriously than shutting down a dozen local mines. Taking this into consideration, as well as the spectacle so frequently seen last winter at Jersey City and other terminal points,—of hundreds of cars of anthracite waiting for a market,—it is evident that an increase of twenty-five million tons of coal could be obtained in 1897 with practically the present plants.

At the October meeting of the Anthracite Coal Operators' Association, two plans were considered for extending the market for anthracite ; and, while these may both be laid aside temporarily, in view of prospective expansion in the ordinary channels of consumption, both merit careful thought in the future. The first plan reported was by Mr. N. W. Perry, for the conversion of anthracite culm into fuel gas. The report showed that, at the present valuation of culm banks, this method of distributing energy is much cheaper for short distances than electric power from Niagara, and that for greater distances it may be economical to convert the culm into electric energy through the medium of fuel gas.

The report of a committee appointed to consider the project of exporting anthracite to Germany in competition with Welsh coal showed that this is at present ruled out by high ocean freights. The plan is full of suggestion, however, for the future.

There is another industry which has reached the stage of a great export movement,—that of crude and refined petroleum,—and, judging from recent developments, the increase in the exports of these oils during 1897 will materially add to our mining revival. Otherwise, the use of illuminating oils is so general and necessary as to make the industry much less dependent upon good times. Still, with any increased industrial activity, the amount of mineral oils used for lubricating machinery, and also the oils used in the wool, rope, leather, and many other industries, as well as the countless industrial demands for paraffin wax, add to the prosperity of the petroleum trade and to the price of the heavier crude oils.

The increased search for natural gas to compensate for a declining supply and greatly-increased demand is also of great benefit to the petroleum prospector. It is difficult to appreciate the great benefit of the oil- and gas-prospecting which is now developing regions of West Virginia, Kentucky, and Tennessee to a position they would not have reached in a century without the aid of a mineral industry.

Building and ornamental stones have felt the dull times to such an extent that the value of the annual product has gone down from over $48,000,000 to less than $35,000,000, the decline of almost thirty per cent. being both in quantity and price. Dr. William C. Day, of Swarthmore College, Pennsylvania, who is recognized as the authority on this subject, writes that an improvement in the stone industry during 1897 is almost inevitable. The feeling of uncertainty during the past few months has postponed many contracts, which will now go over into 1897, so that the latter year will, in effect, appropriate some of the industrial prosperity which under ordinary conditions would have belonged to 1896.

Granite and marble supply most of the demand for high-priced ornamental and monumental material, and therefore feel foreign competition more than any other kinds of stone, which are limited in their application to general structural, building, and other purposes, offering no special inducement for foreign material; hence a natural expectation of tariff support growing out of the election of Major McKinley will be immediately beneficial to the granite and marble industries.

Owing to a number of causes, the prices of both granite and marble have declined during the past five years. Improvements in quarrying, cutting, ornamenting, and polishing processes have undoubtedly had much to do with this decline in cost, but hard times and the desire to keep in operation even at nominal profits have conspired to the low returns. There will not be any great gain in prices in 1897, but the increased prosperity for the industry as a whole will be due to a greater volume of business. In this connection it is interesting to note that some marble producers who formerly marketed only ornamental, polished, or monumental stock are now turning their attention to the production of stone for building. Ornamental and polished granite columns are at present being utilized in whole blocks of houses built for renting, in some of our larger cities.

In the related clay industries there is the usual depressed condition, with an eager outlook for any possible expansion, as shown by the fact that, while last year we marketed the enormous value of $65,000,000 worth of brick and other clay products, the idle plants, according to Mr. Jefferson Middleton, of the United States Survey, could have brought this to over $80,000,000. A product of this value may be anticipated in 1897, and, indeed, noting that nearly all the active plants reported a product greatly below their capacity, a product of $100,000,000 is not improbable in a season of building activity.

No greater contrast can be drawn between the effects of prosperous conditions upon two different mineral industries than is to be seen in the cases of the building-stone and precious-metal industries The former is entirely dependent upon a market which comes with the increased building in a season of even moderate prosperity, while gold and silver, on the contrary, always have an abundant market, no matter how great a product. Still, even these are equally dependent upon the prevalence of prosperous industries to induce the investment of capital in producing them, and our gold and silver mines have felt the recent season of dull times as greatly as any other line of mining work. The prospector goes ahead in all seasons, unreasonably seeking deposits whether he can sell them or not, so that the present condition is one of countless undeveloped deposits of gold and silver, of greater or less importance, waiting for the necessary capital before a product can be realized.

Beside the well-recognized increase in mining activity in the Rocky mountain region, the opportunity for profitable investment in gold mining in the Piedmont region of the south must lead to much greater development. It is in this field that much prosperity must result from the use of new reduction-methods for refractory ores. There is no doubt that the expectations from the great cyanid process and recent advances in chlorination have been altogether too sanguine. Nevertheless, the possibility of treating low-grade ores, practically tailings, by one or another of these devices is leading to more business-like methods in this entire field. That the result means a marked increase in the gold product in 1897 is undoubted.

The effect of recent progress in reducing mining costs should be dwelt upon at greater length than is possible here. But its contribution to mining prosperity can be appreciated, if we think of the possibilities offered for the cheap mining of non-Bessemer iron ores by the steam shovel in the Mesabi region, and for the cheap handling of these and other Lake ores by the system of ore docks on Lake Superior and by the Brown hoisting system at lower Lake ports. The savings effected by these improvements are comparable with the utilization of small sizes of anthracite coal, and the consequent decrease in the waste is from fifty per cent. to twenty per cent. of the total amount mined. This recalls the reduction in cost of electric energy at Niagara, and the consequently less cost of producing aluminum from its ores,—an effect which has already extended the use of this metal for household wares. Electro-chemical improvements in copper- and nickel-refining, and, more recently, in the alkali trade for producing chlorates, caustic alkali, and hydrochloric acid, are lessening the costs of mineral products, but greater than all these are the savings in power by electric installation in mines for haulage, drills, mining machines, hoisting, lighting, firing, and many other ways in regions where water power thus replaces costly fuel.

The saving effected by the introduction of the pneumatic tool in stone sculpture is extending the use of ornamental stone to ordinary buildings. This is small, however, compared to the general benefit secured by use of a greater quantity and superior quality of stone in road-building, in connection with the good roads movement.

Only enumerating such advances in mining and utilizing mineral products as the progressive substitution of pyrites for sulphur in the manufacture of sulphuric acid, the novel method of Frasch for producing sulphur in Louisiana, and his more valuable invention for removing this element from Ohio petroleum, which more than doubles our capacity for furnishing the best grade of illuminating oil, we point out in conclusion a modest, but ingenious, device,—a magnetic separator, brought forward by Messrs. Nitze and Wilkens, the economic effect of which will be felt in many industries in the year to come. By this machine it is practicable and, indeed, easy to remove any iron mineral (except sulphids), even carbonate or silicates, from mixtures of other materials,—an application of magnetism which is new and fairly sensational.

With the combined effect of more active industries and the consequent additional encouragement to the introduction of improved processes, the extent of our mining revival becomes an interesting study for the next twelve months. It is within the ability of the mines of the United States to expand their output within the range of from $500,000,000 to nearly $1,000,000,000 a year in the value of the crude product. We may be well satisfied with $700,000,000. If this is exceeded and the product safely disposed of, it means unprecedented prosperity, not only to the mines, but to the entire country.

The conditions call imperatively for an increase, a great increase, in mining activity in 1897. The product is now proportionately lower than it has ever been. In 1895 the total product was worth $622,687,668, while at the normal increase it should have been $670,000,000. In 1896 the situation will be still farther away from the normal, which would be $700,000,000. This means that the stocks have been so depleted, for most products, that an increase, and a great one, seems absolutely inevitable. The normal rate of increase has frequently been greatly exceeded. If one should hazard a guess as to the products which would make the greatest contribution to this gain, he would naturally select the precious metals. Newly discovered fields of unusual richness and old fields, now made valuable by great reduction in costs of mining and milling ores by the introduction of new or improved processes, are in a position to add to the product.

There is no considerable branch of the mining industry which has not felt the quickening effect of these economies, but the precious metals have been especially benefited. We do not refer to the record-breaking figures at which low grade quartz has been mined at a profit, but rather to the large bodies of low grade ore, as well as old waste dumps, which it has become possible to work profitably by the cyanide process which puts the low grade deposit in the attitude of a newly discovered store of wealth. Thus at Cripple Creek very little ore is shipped which carries less than $25 a ton in telluride of gold, although in most localities $7 ore would be shipped, and still poorer ore might pay expenses. Already there are large dumps at most of the Cripple Creek mines which exceed $7 in gold, and these must surely be used at future local cyanide mills.

Among the new gold fields of the United States, that at Gunnison, Colorado, and those in the Black Hills seem of unusual promise. Again, the reaction from the South African excitement is sending much capital into British Columbia, notably to Trail Creek. There is no question but that this camp will show a great increase next year, and as the branches from our own railroads are reaching into the region we will get the largest part of the ores to smelt.

THE WONDERFUL EXPANSION IN THE USE OF ELECTRIC POWER.

By Louis Bell.

THE transmission and distribution of energy is the latest of the great electrical arts. To be sure, in the almost prehistoric days before the invention of the dynamo, there were electric motors, as there were electric locomotives and electric lights, electric heaters and electric boats; but the ingenuity of Henry, Jacobi, Davidson, and Page led to no useful end. Their machines were relegated to the scrap-heap or the cabinet shelf by the same grim logic of economy that, in the fullness of time, has forced the modern motor into the front rank of industrial improvement.

When, just a quarter of a century ago, Gramme and Siemens gave the dynamo substantially its present form, every kind of electrical work received a sudden and powerful impetus. The subsequent half-dozen years were crowded with developments. In 1873 the first motor of modern type was put into operation at the Vienna Exposition by Fontaine and Breguet, the motor working a little pump through a mile or so of cable. In the next few years motors were occasionally exhibited or put to temporary use, but it was not until the autumn of 1878 that experiments and demonstrations culminated in commercial operation.

The time was propitious; the growth of electro-plating and electrotyping had given the dynamo-builders encouragement and occupation; the arc lamp had outgrown the laboratory and the lecture-room, and was becoming a practical illuminant. It was whispered, too, that, if the experiments then in progress on incandescent lamps were successful on a commercial scale, the problem of general electric lighting was to be at last accounted as solved.

More than this, some convenient and economical means of transmitting and distributing mechanical power had long been badly needed, and men were ready to turn hopefully to the potent force that had already achieved so much. Power transmission by wire ropes and by compressed air had already been weighed in the uncompromising balance of experience, and had been found wanting,— the former in flexibility, the latter in efficiency.

In the latter part of 1878 MM. Chrétien and Félix installed in the beet-sugar works at Sermaige the first commercial electric motor, operating a little hoist used in unloading the beets from the boats in which they were brought down the river. During the succeeding winter four thousand tons of beets were thus unloaded, and the cost was found to be about forty per cent. less than unloading by hand The appearance of this historical motor is shown in Fig. 1. It developed only two or three horse power, and received its energy from a similar generator about twenty rods away. From this beginning has sprung the prodigious growth of to-day.

The next summer the first electric railway was put into operation at the Berlin Exhibition,—a single car, capable of carrying fifteen or twenty passengers, and running over fifty rods of track. The transmission of energy to both stationary and moving motors was quickly taken up in this country. S. D. Field and Edison were pioneers in the work; in fact, the former was actively experimenting when the foreign work was made known; and presently scores of inventors were busy, with true Yankee push, in working out the manifold applications of electrical motive power.

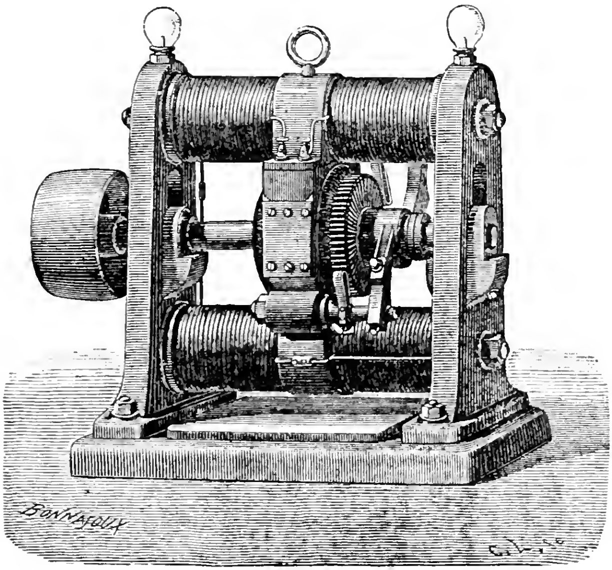


FIG. I. ONE OF THE FIRST COMMERCIAL MOTORS

At first the only available sources of current were the recently-established arc-light circuits. Upon these small motors began to appear soon after 1880, and with increasing frequency in the next succeeding years. Soon Edison lighting-stations became available, and during 1882 and 1883 small motors began to go into service in connection with them. By the fall of 1884, when the Philadelphia Electrical Exhibition was in progress, the electric motor was firmly established as a machine commercially available, and its valuable properties were well understood. In fact, the Electrical Expositions of 1881 in Paris and 1882 in Munich had shown the capabilities of motor service, and at the latter had been shown the first experiment in long distance power transmission,—an experiment more daring and revolutionary even than the famous one at Lauffen-Frankfort nine years later.

This work was done by Marcel Deprez, and consisted in the transmission of power from Miesbach to Munich, — thirty-seven miles, a distance longer than is spanned by any commercial plant in operation to-day. The line was of common telegraph wire, and the energy delivered was less than half a horse power, which was employed in driving a centrifugal pump. The voltage of the dynamo was about 1350, and both generator and motor were specially-wound Gramme machines. The station at Miesbach, the first power-transmission plant in the world, is shown above in Fig. 2.

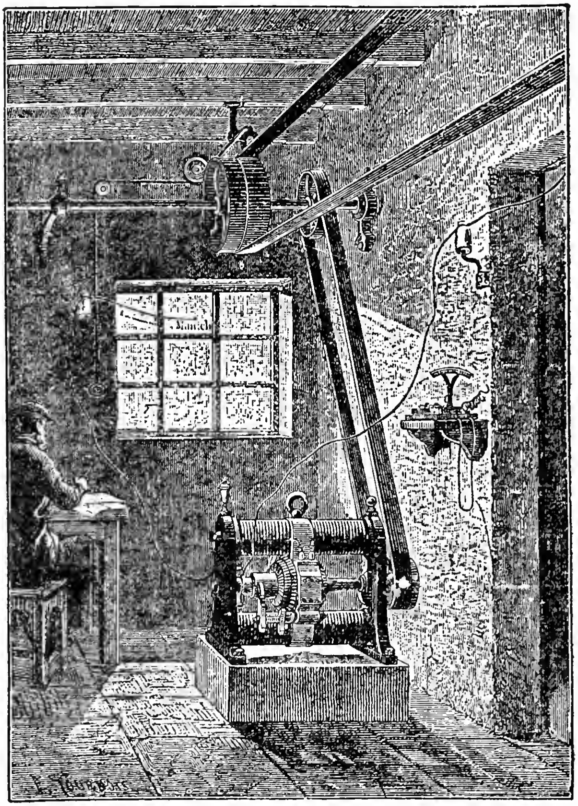


FIG. 2. THE MIESBACH POWER STATION.

From 1884 the development of the motor, following up the growth of electric lighting, was increasingly rapid, and by the autumn of 1886 it was estimated that there were no less than five thousand electric motors in use in the United States.

At the same period there were nine electric railways in operation, running fifty-eight motor cars and aggregating thirty-five and one-half miles of track. Many battery motors are included in this estimate, and the arc circuit was still an important source of power.

Thereafter the growth of the art was mainly in the direction of railway service, though the incandescent lighting stations soon began to take on motor service in considerable amounts.

In 1888 came the Tesla motor that has since played so important a part in the development of electric power, particularly in the past few years. As electric railways became more and more common, and engineers became more familiar with the construction and management of dynamos for fairly high voltages, motor work began to assume larger proportions and to reach out over greater distances. A few special motor circuits were installed at 220 and 500 volts, and a successful series motor distribution was started in San Francisco. But more experience was needed, and the time was not yet ripe, so that it was not until 1890 that power transmission as such began to gather headway. From 1890 dates the real period of industrial development.

By this time it was well ascertained that the electric motor was a thoroughly efficient and reliable machine, capable of being trusted with important work and fully able to compete with steam power under conditions that could often be realized. With power derived from ordinary central stations the motor was often far more economical in its operation than small steam engines with their attendant inconvenience and care; and it was obvious enough that no known means of transmitting power was so efficient or convenient for general purposes. Given a cheap source of power, the problem of its economical distribution was at last solved.

It was but natural that the mining regions of the far west, where coal was very expensive and water power plenty, should have been the scene of the first attempts at the electrical transmission of power. About the beginning of 1890 several transmission plants were put in operation, employing for the most part 500-volt railway generator and distributing power for mills, pumps, and hoists. This was only a useful makeshift, and it was necessary to break away from ordinary voltages before power transmission could assume the industrial importance that is its due. The step was not an easy one, for high voltage was a dreadful bug-a-boo in 1890; but taken it was, both with continuous and with alternating currents, and early in the next season two notable plants went into operation: one at the Dalmatia Mine, California, transmitting 100 h. p. at 1,800 volts 1½ miles; the other at Telluride, Col., delivering a similar amount of power 2½ miles away by means of a monophase alternating current at an effective pressure of 3,000 volts. A single synchronous motor was used, brought up to speed by a Tesla split-phase starting motor. At the Dalmatia Mine Brush continuous-current machines were used, one at each end of the line.

The polyphase systems were as yet undeveloped, as shown by the use of monophase current instead; but the Tesla motor had already been in use, for in the summer of 1890 several Hercules mining machines had been equipped with them and put into regular service near Pittsburg. One of these pioneer machines—the first commercial polyphase induction motor—is shown in Fig. 3. Then, in the summer of 1891, came the Frankfort Electrical Exhibition, which gave to electric power development the final impulse needed. Since then the transmission work in this country has been, with a few trivial exceptions, entirely polyphase. The next year saw much experimentation, much growth of ordinary motor service, but no power-transmission plants, save a small monophase synchronous one at Walla Walla, Washington, and another, closely similar to the Telluride plant, but of double the capacity, and working over a line 12½ miles long, at Bodie, Cal. A notable step was taken, however, in the establishment of a long-distance lighting plant, delivering energy from the generating plant in San Antonio Cañon to the towns of Pomona and San Bernar-

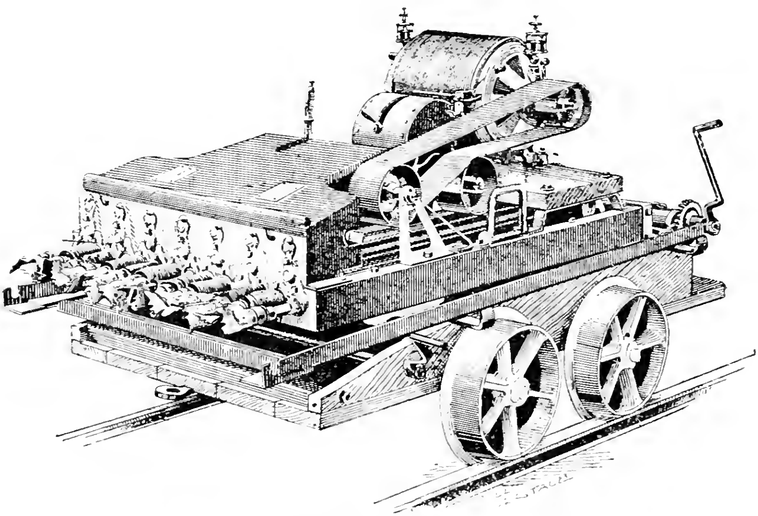


FIG. 3. HERCULES MINING-MACHINE WITH TESLA MOTOR.

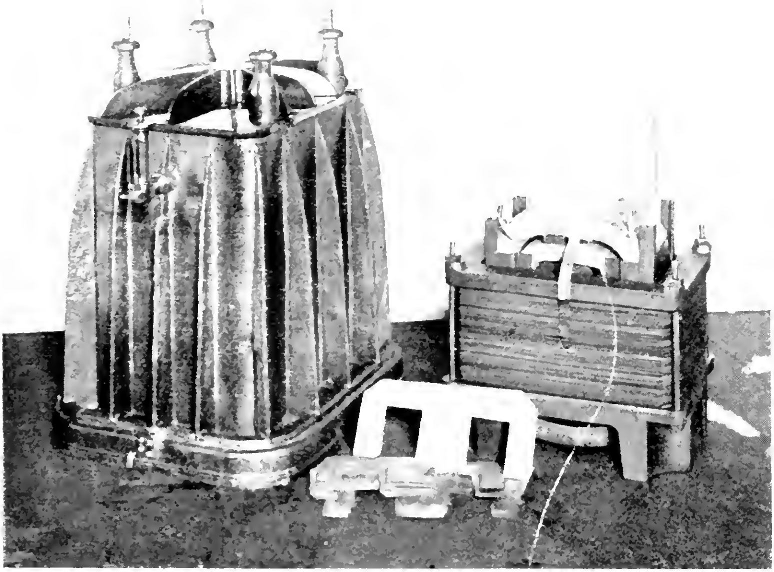


FIG. 4. POMONA TYPE TRANSFORMER.

dino, Cal., distant respectively $13\frac{3}{4}$ and $28\frac{3}{4}$ miles. An ordinary alternating generator was used, but the voltage was raised to 10,000 volts by a bank of twenty step-up transformers in series. It was the first commercial use of so high a pressure, and the extreme distance of transmission has been exceeded only within the past year. One of these historical raising transformers is shown in Fig. 4.

The hard times were now drawing near, but the good work went along, and 1893 saw marked and substantial progress in the use of electric motive power. Not only was there steady increase in the installation of motors for every purpose, but the Columbian Exposition was rich in transmission apparatus, and before the end of the year three polyphase plants had gone into service, and—what was worthy of special note—the final steps had been taken to furnish the great Niagara plant with generators of American design and manufacture.

During the times of dire financial stress in 1893 and 1894, when many industries were completely prostrated, the electrical distribution of power grew as it had never grown before. Business men saw an opportunity of reducing operating expenses by securing cheap power, and grasped it. Aside from all the motors sold for factories and work-shops, contracts were made by the leading electrical companies for more than a score of polyphase transmission plants.

Notable among these were two great cotton mills at Columbia and Pelzer, S. C., equipped throughout with polyphase motors, for the most part applied directly to groups of machines, dispensing with the costly and complicated systems of belting and shafting heretofore used in such factories. Fig. 5 shows the generating plant at Pelzer, with its three 750-kilowatt three-phase generators, directly coupled to turbines, delivering current at 3,300 volts to the mills 3½ miles away.

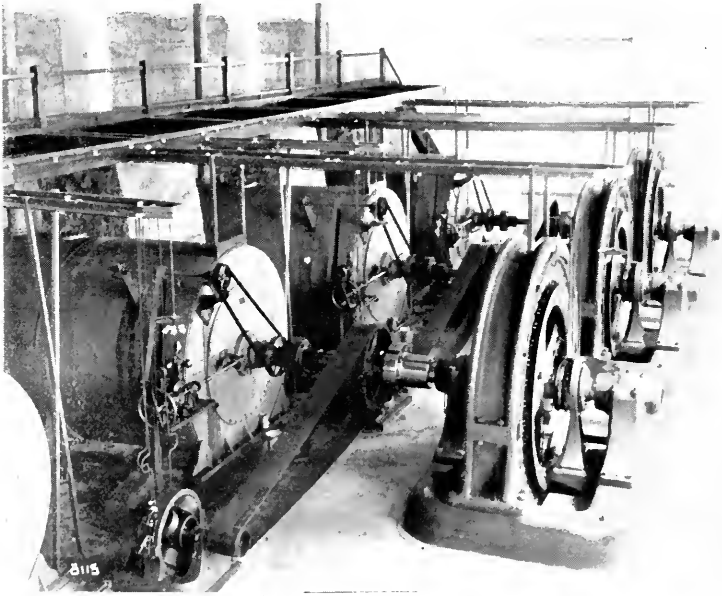


FIG. 5 THE PELZER DYNAMO ROOM.

The next year saw increased activity and epoch-making work. In the early summer the Folsom-Sacramento three-phase plant went into operation, of 3,000 kilowatts capacity, furnishing all the power and light used in Sacramento 23 miles away,—the longest commercial transmission that had yet been installed. A little later the huge Niagara plant went into operation with its 5,000-h. p. generators,—an installation that for size and startling engineering features will stand unique for many a year to come. Fig. 6 shows the present appearance of this immense station, of which so much has been heard of late that further description is needless.

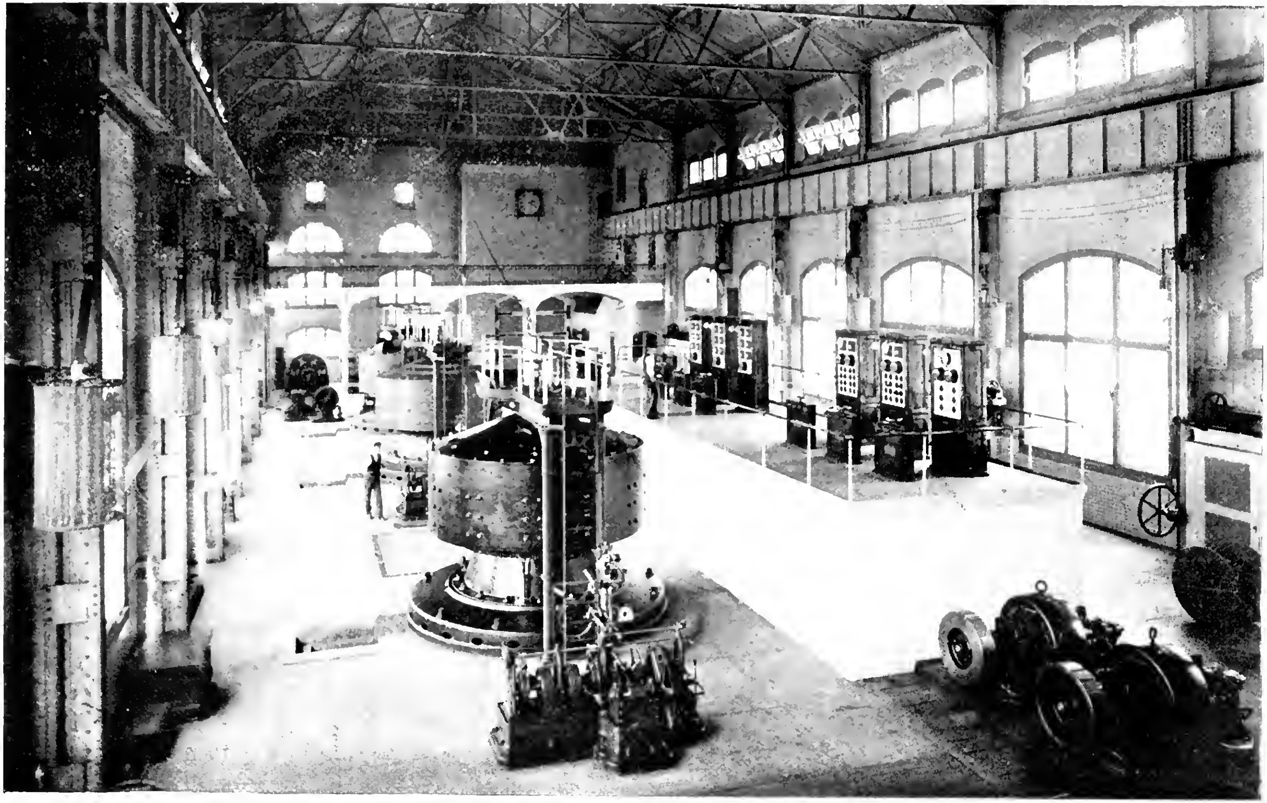


FIG. 6. INTERIOR OF THE GREAT NIAGARA POWER STATION.

In early autumn another sensational advance was scored in the starting of the enormous electric locomotives in the Baltimore & Ohio tunnel under the city of Baltimore. These colossal machines more than equalled in power the largest freight locomotives in existence, and their performance made the first great inroad into the realm of heavy railroad work,—an incursion that will be pushed into the very citadel of steam. Fig. 7 shows one of these locomotives, weighing 96 tons, and with a draw bar pull of more than 60,000 pounds.

Motor plants of every kind have multiplied, and the past year has seen greater progress than any which preceded it. Specially notable has been the transmission of power 35 miles into Fresno, Cal., at 11,000 volts,—the longest commercial transmission yet accomplished

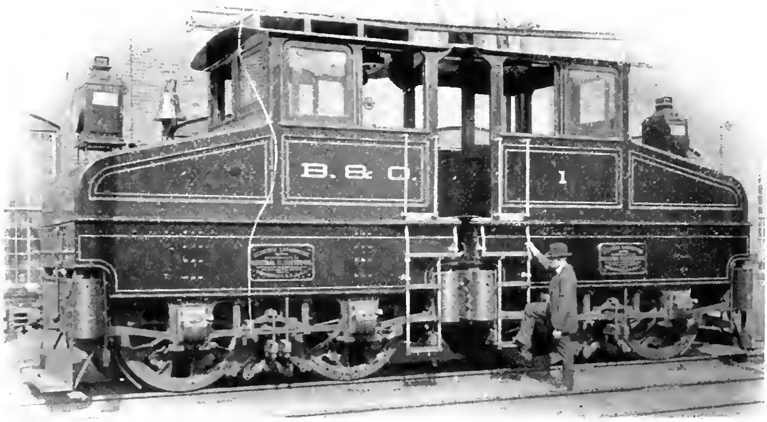


FIG. 7. BALTIMORE AND OHIO ELECTRIC LOCOMOTIVE.

anywhere; and very recently the long-delayed delivery of power from Niagara to Buffalo,—1,000 h. p. over a 27-mile line, with immense increase in immediate prospect.

And through all this growth one fact has been conspicuous; wherever electric power has come, it has found a profitable market; the steam engine has gone out, and the electric motor has come in. There has been no failure, no long struggle with unprofitable conditions; the motor has done its work, and pushed its competitors to the wall.

It is hard, indeed, to estimate the growth of electric motive power during the last decade. In place of the little group of struggling electric roads of ten years ago, we have to-day very nearly 13,000 miles of track equipped with not less than 30,000 motor cars. The railway motors in use aggregate fully a million horse power, and the generating plants close to five hundred thousand.

During the year just past, about 1,900 miles of electric-railway track have been built, and nearly 5,000 motor cars have been added to the equipment list. This increase means an aggregate investment of something like $35,000,000,—a prodigious sum to be added to a single industry in a year that has been far from prosperous.

Of stationary electric motors the number defies exact calculation, in so many directions and from so many sources has the growth extended. A single plant in New York city carries nearly 10,000 h. p. in motors upon its circuits, and the aggregate of those thus operated from central stations primarily intended for lighting certainly reaches 100,000 h. p. Those operated by scattered stations and power-transmission plants, and used in miscellaneous ways, bring the probable total amount of power to 250,000 h. p. Including railway work, it is safe to say that the gross power of the electric motors used in the United States is at present not less than 1,250,000 h. p. Of power-transmission plants proper, inaugurated mainly for motor purposes, there are now probably 150,—about 100 of them using the modern polyphase systems, which, by simplifying the question of distribution, have made power transmission practicable. A score of these plants transmit power 10 miles or more, and half a dozen over 20 miles. When we compare such a list with the little group of small power plants that were running five years ago, the strength of the cause that has scored such gains in times so troublous is self-evident.

The secret of this astonishing growth lies in the simple fact that capital will be invested to effect certain retrenchment even when it cannot be obtained for any other purpose. In prosperity men will work harder to make a dollar than to save one ; in adversity this tendency is reversed.

The saving secured by the use of electric power is so considerable in many cases that ordinary prudence has demanded a sufficient investment to secure this advantage. One of the mining plants to which reference has been made has been paying for itself at the rate of five per cent. a month. Under many conditions electric power must now be regarded as an industrial necessity. Its position is secure, and the burden of proof rests to-day upon those who doubt.

For the future the outlook is bright. The pioneering period has gone by, and present successes render argument needless. The growth of the next few years will be along two lines. First, we shall see an enormous extension of electric-railway work. The steam railroads are beginning to submit to the inevitable, and one by one we shall see them employing electricity, certainly for branch and suburban service, perhaps even on long lines.

When the public wants an express service at 100 miles per hour,

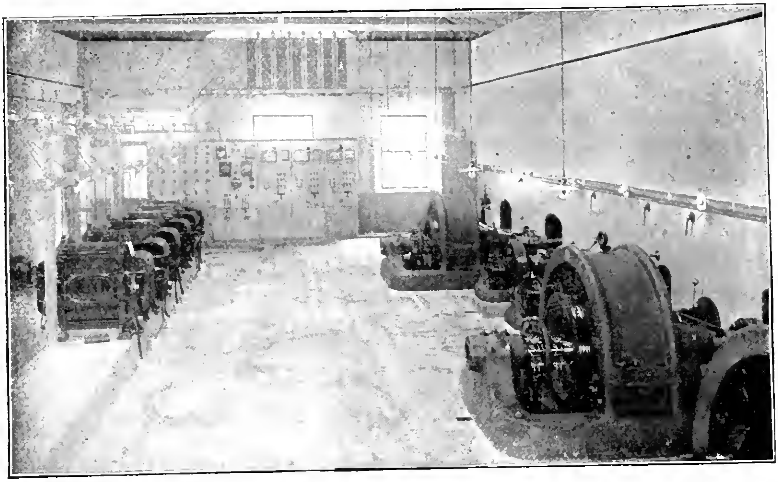
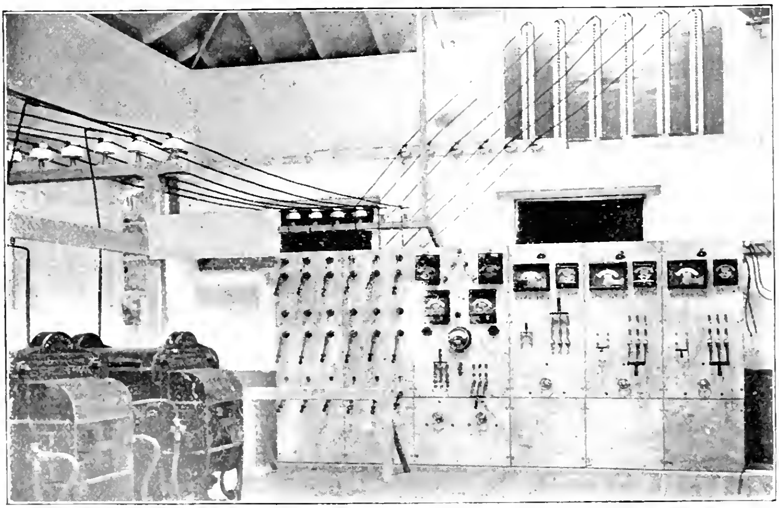


FIG. 8. THE GENERATOR ROOM OF THE FRESNO POWER-PLANT.

the means is at hand, and very little experimenting will have to be done. Not less important in its effect on the people is the growth of small electric roads in the country districts, tending to check the centralization of population and industry that is so grave a cause for anxiety in our national growth.



HIGH TENSION LINES LEADING FROM THE FRESNO STATION.

Second, there will be in the immediate future an immense development of the natural power resources of the country. One of the curious results of the power-transmission work already accomplished has been the rediscovery of numerous water powers which were quite forgotten until electrical power transmission called attention to them. Some of these have lurked in the most unsuspected places, where all the conspicuous powers had long ago been utilized. There are unemployed water powers enough within fifty miles of New York to displace every steam engine in the metropolis at a profit, if they were but rendered available.

It is now certain that the distance mentioned can be successfully overcome by apparatus already available. The recent transmission of power 35 miles into Fresno, Cal., already mentioned, has made clear the way, and no appreciable difficulties can be met in fifteen or twenty miles more. This Fresno plant, notable as the longest transmission in the world, is worthy of further description. The power house far up among the hills is shown in Fig. 8. The motive power is obtained from Pelton wheels working under an effective head of more than 1,400 feet. Each wheel is directly coupled to a three-phase generator, delivering current to the raising transformers at a pressure of 700 volts. It leaves the transformers at 11,000 volts for its long line through the foot hills and the San Joaquin valley into Fresno.

The present transmission is about 1,000 h. p., devoted to the distribution of light and power in Fresno and neighboring towns. Until this line went into operation, there was some distrust of very-long-distance work, some fears of unexpected and unpleasant developments that might be met on very long alternating-current circuits. These fears have now been finally dispelled by success, and, long before the power of Niagara was delivered in Buffalo, the success of that momentous enterprise was made certain, so far as electrical difficulties go, by the experience acquired in distant California.

With the power of overcoming long distances that has now been gained, a field is opened for the employment of electric power, the extent of which nothing short of prophesy can estimate. Not less than 5,000,000 hydraulic h. p. is ready to be utilized in this country of ours, when industry calls for it. Water power, to be sure, is not invariably a cheaper source of energy than coal, but the chances are generally in its favor.

And when water power is unavailable, there remains the splendid possibility of transmitting electrical energy instead of hauling coal,—taking the fuel at the pit's mouth and using it to spin electric motors in the thousand factories of a city fifty or one hundred miles away. The first steps have been taken in this direction already, and some progress, at least, is certain. The time has come when cities will begin to defend themselves against the defilement of the free air. The smoke palls that hang gloomily over most large cities are blots on our boasted civilization, and they are to-day without the excuse of necessity or economy. More than this, they have passed beyond the bounds of toleration, and the general tendency of municipal legislation is now to enforce the remedy which hygiene, comfort, and domestic economy unite in demanding.

There is no good reason why every wheel that turns within the limits of a large city should not derive its motive power from a plant far beyond the city limits. Moreover, at prices now reached not infrequently by electrical-transmission plants, heating by electricity becomes economically practicable. With heat, light, and power derived from a single great plant, almost ideal conditions are realized, and such a possibility is now within our reach. When so splendid a goal is in sight, there is little chance that the advantage already gained will be lost through slothfulness and neglect, and for the great tasks pertaining to human industry electrical power will ere long have no serious competitor.

The illustrations of the Miesbach power station and the Hercules mining machine are republished by permission of *The Electrical World*.

THE STIMULUS OF COMPETITION IN ARCHITECTURAL CONSTRUCTION.

By Dankmar Adler.

HOWEVER the outward surroundings of the men of to-day may differ from those of the men whose existence was coeval with the dawn of civilization; however man's command over the animate and inanimate world and over the forces of nature may have increased since he first sought shelter from the elements and protection against the attacks of wild beasts,—the underlying traits, instincts, and emotions of human nature remain unchanged, and are as potent to-day as they were in the time of contemporaries of the cave-bear and the mammoth.

Dissatisfaction with things existing; hope for betterment from things to be worked for and attained; observation, invention, imitation, emulation,—all these distinguish man from the most intelligent of beasts; and the exercise and development of these tendencies and faculties have brought mankind to conditions of life and power so different from those of even the noblest animals that the idea of common origin of man and beast seems preposterous to many well-informed and thinking persons.

When the possibility of obtaining protection and shelter in walled and roofed enclosures first dawned upon primeval man, the initial and most important step toward the subjugation of the rest of creation was taken by our ancestors. Excepting only the discovery of fire, no invention or discovery has been more fruitful of results than was the invention and discovery of the house, however primitive and rudimentary may have been the form in which it first appeared among men. And from the day of the first utilization of a cave as a human habitation; from the hour when the first crude hut protected a human family from the scorching sun and pelting rain; from the time when walls of rocks, of mud, or of logs, first gave protection and vantage to man in his struggle with the wild beast,—the history of the development and progress of the human race has been coincident with the development and progress of the art and science of building. The fathers whose ingenuity and industry provided the most efficient shelter were able to rear offspring more numerous and more healthy and strong than their less ingenious and less industrious competitors in the struggle for existence. So also in the care of herds and flocks, in their shelter from wind and rain and snow and their protection against the attacks of wolves and other natural enemies, and in the struggle of men against each other, success and fortune were ever with those who knew how to rear the sheltering and protecting structures best adapted to their various functions. And thus the families, tribes, and nations by whom the art of building was most assiduously cultivated were those which waxed most numerous, prosperous, and strong, while the families and tribes who were content to exist without artificial shelter, or were satisfied with the rudiments of hut- and house-building, became extinct; or, if their existence was prolonged, it was often in servitude and slavery to those more intelligent and industrious tribes and nations by whom architecture had been originated, developed, and cultivated. While it is true that hardy hosts of cave- and hut-inhabiting barbarians, envious and covetous of the comfort and wealth of the highly-prosperous house-dwellers of Assyria, Babylon, Egypt, Troy, Greece, Rome, and scores of other civilizations swooped down upon and overran and conquered their more highly civilized, but much less numerous, neighbors by sheer force of numbers, it is also true that these barbarians were themselves captured and overmastered by the civilizations whose creators and conservators they had set out to annihilate, and whose fruits and products they had come to appropriate. For among the first lessons of civilization learned by the conquering barbarians was appreciation of the advantages of dwelling in houses, of fighting behind fortifications, and of worshipping their gods in temples. They took up the architectural methods of the vanquished peoples, engrafted their own crude vigor upon them, and worked out new styles in harmony with their own individualities.

Thus, while nations perished, the art of building lived on to continually wider and more diversified development, always modifying and adapting itself to the dominating requirements and conditions of the changing times and periods and always continuing an essential factor in the struggle for existence and for the survival of the fittest among men.

Of the various forms in which records of bygone ages and races have been preserved for our instruction, none is more prolific of information as to what manner of people lived in the past, and what were their customs, manners, and characters, than their architecture, as it reveals itself to us in the remains of the public and private buildings, and of the roads, bridges, and aqueducts of communities once made up of people to whom steam and electricity, the railroad and telegraph, the compass, the steamship, the rolling-mill, the converter, the telephone, the sewing-machine, and the type-writer were unknown, but whose emotions, impulses, and passions, as revealed to us by their architectural remains, were very much the same as our own.

The house was man's first fixed possession, and its existence gave the first title to the ownership of land; and with that ownership a shelter from behind whose walls ownership of ground and house and the possession of the contained goods and chattels and surrounding fields and flocks could be advantageously defended. Rivalry and competition in the effort to select the best possible sites and to build the best possible houses must have begun at a very early day, and must have been strongest among the families which succeeded in surpassing other in increase of numbers and maintenance of health, strength, and wealth; the dignity of the family being indicated by the size, solidity, and ornateness of its domicile, and the number of families thus distinguishing themselves being in its turn indicative of the power and standing of the tribe or nation. It was then but a step to corresponding rivalry and competition in the efforts to erect temples for the worship of the family and tribal deities; and the greatness and power of the various gods was measured by the size and splendor of the temples erected in their honor. And, after civic pride had come into being, the wealth and the glory of the cities were emphasized, not only by the character of the habitations of their citizens and by the number and splendor of their temples, but by their council-houses and theatres, bath-houses, aqueducts, ways and roads of communication, bridges, and other public works, the extent and character of which, in each community and in every epoch, give testimony to the existence of most intense rivalry and competition. This emulation and strife, the competition born of "the divine spirit of discontent," was strongest among the families, tribes, and nations that rose to the higher level of civilization, and among these the desire of every man to excel his neighbor was most potent in its manifestations. These characteristics have gathered strength from age to age, and are still among the most powerful of the many forces which work for the continued advancement of the human race.

The desire to use architectural works as a means of aiding and furthering human progress and of celebrating and commemorating human attainments and triumphs has always found utterance during times of peace and prosperity, and has been repressed during the prevalence of war, or other disasters or general disturbances of public well-being, and has again developed and manifested itself upon the return of peace and prosperity.

The unremitting daily toil of the millions of workers of the world is chiefly expended upon the maintenance in physical comfort of the human race, and each day is witness of the consumption and consequent annihilation of the greater part of the product of the day before. Yet there is always in times of prosperity an overproduction, from which arises an accumulation of the products of human industry sufficient to supply sustenance for the constant increase of the world's population, and to carry us over periods of disaster and distress. The daily production of things to be consumed on the morrow is indispensable to man's maintenance on the earth, but only that which is not consumed, but stored up for future use, contributes and adds to man's and the world's wealth. In all that can be used as food or as apparel for man or to minister to man's comfort and welfare, overproduction is not the bugaboo which thoughtless writers and speakers would have us believe it to be. On the contrary, it is only a wholesome preparation made in the years of "the fat kine" for the period of "the lean kine," which has repeated itself over and over again both before and since the days of Joseph and Pharaoh.

There is, however, a kind of overproduction, or, rather, malproduction, which is synonymous with waste, and which, strange as it may appear, is due to man's restless activity, ingenuity, and progressiveness. It is found in the many tools, machines, and processes for doing the world's work which, before having outlived their normal period of usefulness, are supplanted by others better adapted to their essential requirements and functions. Many products and appliances turned out by human industry, but which are ill adapted to their intended purposes and uses, should also be classed as malproductions. Financial crises are not caused by excessive yields of food products, or of wool and cotton and leather, or of metals from our mines. But, when the accumulations of the world's surplus earnings, actual and prospective, are expended and pledged in payment for proposed new and improved means and aids to production, communication, and transportation, and when these are in excess of what the world can utilize within a reasonable time, or are intended to supplement and supplant other means of service still capable of further utilization, and when errors of judgment like these have been committed on a large scale, and there is also a great volume of malproductions of the character before referred to, then the waste of energy and the impairment of accumulated wealth assume alarming proportions, and panic and disaster ensue. Everything that cannot be immediately utilized becomes unnegotiable and valueless, and even those things for which an immediate demand exists cannot be sold or pledged for their actual intrinsic value.

Heretofore architectural structures of all kinds were almost altogether exempt from these mutations of value, and appear to have stood through the stress of panics and financial depressions as fixed representatives of accumulated solid wealth. Until the latter half of the present century, the evolution of new conditions and wants among men was slow, changes were few and far between, and stability of essential characteristics prevailed and was represented and illustrated in the architectural expression and development of the past. A house or building of any kind once built, a bridge or road once constructed and kept in good repair, were depended upon to maintain their value for an indefinite period, and their ownership was for ages the favorite form of investment for the accumulated wealth of the strong and thrifty, considered assailable only by the destructive agency of war.

The development of new industrial and commercial conditions and the accompanying enormous increase of accumulated wealth have brought about a readjustment of standards of utility, and therefore of the value of buildings and structures,—a wholesale abandonment and demolition of houses, bridges, aqueducts, and other architectural works, and their replacement by others intended to be better adapted to present and future conditions than their predecessors.

It must not be inferred from this that architecture is losing its character as the chief and final depository of man's accumulated wealth, as the enduring monument and final expression of the powers of achievement of its age and period, but if architecture is to continue its former relations to human achievement and progress, it must accelerate its pace to that of the man of the nineteenth and twentieth centuries, and, in order to continue its time-honored functions, it must adapt itself to the quickened movements and impulses of the new day. The effort to do this has undoubtedly been made, and visible progress has been achieved toward the solution of the problem how to reconcile the ideas of permanence, stability, monumentalism, with the spirit of skepticism, inquiry, change, and progress, which characterizes our period of the world's history. We cannot, however, close our eyes to the fact that architecture has contributed its share to that aggregate of malproduction which was one of the chief causes of the years of financial panic and business stagnation, from the effects of which we are about to recover.

Changes in standard of living, discoveries in sanitary science, new methods of transacting business, the development and differentiation of manufacturing processes and of labor-saving devices, the invention of electric light and electric power transmission, and the introduction of cable and electric railways have been instrumental in depriving many existing buildings of their usefulness and their adaptation to the purposes and requirements of our day.

The era of confidence in the soundness, stability, and integrity of the financial and business conditions upon which we have entered will revive and stimulate the spirits of enterprise and invention; these will create and develop new means of obtaining wealth and new avenues of employment for the industrious and enterprising,—new opportunities for earning and accumulating surplus wealth. At first all will be mindful of the terrors of the panic and its causes, and therefore cautious and conservative, distrustful of the commercial value of the higher flights of enterprising inventors and enthusiastic promoters. But gradually distrust and caution will wear away, over-confidence and dauing will follow and increase, wholesome overproduction and accumulation of surplus will diminish, and malproduction will increase until another panic shall appear in the land.

But, for the present, millions of dollars are awaiting investment in commerce and manufactures. Ere long large sums will go towards the enlargement and development of existing enterprises, and more into new ventures and excursions into hitherto untrodden paths of industrial and commercial progress, the latter undoubtedly requiring new buildings adapted to novel requirements. Among all there will arise keen rivalry and competition to secure the best possible housing for carrying on the various enterprises, and every success in so doing will stimulate the efforts of competitors into eagerness for still better architectural results. As the earnings of the newly-invested funds will bring forth further supplies of capital, its owners will be carried by the general spirit of rivalry into further outlay upon better and better buildings. And so the struggle will continue, and increase in fierceness and intensity, and merchants, manufacturers, and capitalists will vie with one another in efforts to attain the highest and best results. Architecture and architects will be drawn into conflict, certainly to their own financial betterment; whether for the betterment of the general situation depends upon themselves. They will be carried along by the rush, and upon their success in so directing, limiting, and guiding the movements of the competing and struggling forces as to prevent waste and unnecessary risk of capital depends the status of American architecture and architects in the next half century.

Architecture and architects are man's creation and man's servants, and cannot avoid participation in every movement, for good or for ill, by which human society is swayed. As a man may combat evil hereditary tendencies, defy the influences of immoral surroundings, resist temptation to do evil, and develop into true and noble manhood, so also may the architect recognize evil tendencies and check them, note and recognize errors of judgment and avert them, turn funds from intended extravagance and malproduction into the channels of prudent and wholesome expenditure, and thus do his share toward prolonging the coming period of prosperity and minimizing the force and duration of the coming panic.

To be able to do this and to be an architect, a master-workman, not only in a material sense, but in the control and guidance of the mental and emotional forces which make for the transmutation of the world's surplus wealth into architectural works, the architect not only must have acquired knowledge and command of the alphabet, grammar, syntax, and rhetoric of the many phases of his own art, science, and profession, but must have studied and mastered the history and philosophy of the development and progress of human society, of the rise and growth of science, invention, and discovery, and must have trained his mind to forecast the trend of coming scientific achievements and their probable practical applications to and effects upon human affairs.

No one architect can attain this standard, but each individual architect can keep it in view, and every one can try to come as near to it as his opportunities will permit. All can learn from each other; all can teach others, and acquire and impart knowledge in their intercourse with clients, contractors, artisans, and the general public. All can study the works and the literature of the past and present, and may, through the public and professional press, tell their contemporaries and their successors what they have learned through experience and study. Thus can the profession of architecture show itself worthy of its mission to be the conservator of the world's accumulated and invested surplus wealth.

During the approaching era of business prosperity innumerable architectural works will be undertaken. It lies with their designers whether or not they shall fulfil their intended immediate functions. It will be for their architects to ascertain whether these functions are likely to be temporary or enduring, and whether, therefore, the buildings shall be but temporary in their character, involving but little outlay, or permanent, and become the depositories of large volumes of the world's accumulated capital. If permanent structures are required, there is still the problem to be solved whether any preparation is to be made for the changes the future may bring forth, and what will be the character, extent, and trend of the expected developments and changes; and whether or not such preparations for future developments can be made without impairing the present value of the structure.

Upon the more or less successful solution of such problems as these will depend the status of the architect and his profession during the coming years. If they are correct, much mal-production and waste will be averted, and architecture will maintain its time-honored function as the receiver and guardian of the accumulated wealth of the ages, without failing to bear its part in the progress and work of the day, and in the competition and emulation of men in the struggle to surpass one another which lies at the foundation of human progress.

LABOR-SAVING MACHINERY THE SECRET OF CHEAP PRODUCTION.

By A. E. Outerbridge, Jr.

THERE is an evident impression in the minds of some employers of labor in this country at the present day that the only hope of successful competition with foreign countries, where labor is comparatively cheap, is to be found in a reduction of the wage-scale to approximate the low standard prevailing in those countries.

The purpose of this paper is to show the fallacy of this view, and to prove by argument and illustration that the true secret of success lies in an opposite direction. Careful observation and study of this important economic problem have convinced the writer that, wherever American manufacturers have, in the past, successfully competed in the markets of the world with similar products of foreign make, the success has been due to a fortuitous combination of improved labor-saving machinery operated by high-priced, intelligent mechanics, and that greater developments in the future should be sought in the same direction, not in reducing wages and lowering standards.

Certain fundamental principles have characterized American methods of manufacture, such as the adoption of interchangeability of parts and the designing of special machines to perform specific operations only, whereby the output of a factory is enormously increased, division of labor systematized, the costly work of finishing and adjusting minimized, and the highest development of skill, accuracy, and despatch acquired. These features have, perhaps, received most notable development in the fine art of watch-making by machinery in America, wherein the acme of perfection and economy is exhibited.

The system of concentration of labor in large factories for making watches in this country is the antithesis of the method of scattered manufacturing which prevailed for centuries in Europe, notably in Switzerland. M. Favre-Peret, who investigated this industry in the New England States some years ago, stated that the average production of 40,000 workmen in Switzerland was 40 watches per annum for each workman, while in America the average was 150 fine watches for each man employed.

In the operation of cutting and setting "pillars" by hand 30 per day represented a full day's labor, whereas, by the aid of the Elgin pillar-cutter, 2,000 pillars per day were produced by one operator. Again, in cutting the the teeth of certain wheels, one operative will cut, with one machine, 1,200 wheels, having 96,000 teeth, per day, the cutting mills making 7,000 revolutions per minute.

By the aid of machinery one man can make 1,200 fine screws a day, some of which are so small that more than 100,000 are required to weigh a pound.

One of the finest pieces made is a "pallet-arbor," or pivotal bolt, which, for a small-sized watch, has a thread of 260 to the inch, weighs $\frac{1}{130000}$ of a pound, undergoes 25 operations, and costs but $2\frac{1}{4}$ cents. Measurements are gaged to $\frac{1}{25000}$ of an inch.

There are 80 separate operations upon a balance-wheel, 66 of them being drilling, threading, and countersinking holes; the drills revolve at a speed of 48,000 turns a minute, and one operator can drill upwards of 2,200 holes for the balance-wheels in a day. The balance-wheel, after being machined, weighs only 7 grains, and, when fitted with 16 gold screws, weighs 7.2 grains. It is customary in the large watch factories to start the manufacture of different grades of watches in lots of perhaps 1,000 of each kind at one time.*

The result of this marvelous development of labor-saving machinery and systematizing of methods of manufacture has been a reduction of the cost of excellent time-keepers to a point which enables every mechanic, farmer, and schoolboy to possess a reliable watch. American watches are exported, in competition with foreign watches, in enormous numbers to all parts of the world, and, notwithstanding the low prices, the business has yielded enormous profits.

By way of supplementing the foregoing record of development in delicate machinery it may be interesting to briefly refer to the economies which have resulted from the introduction of improved facilities for handling enormously heavy materials used in large engineering constructions. In place of the old-fashioned, cumbersome, slow-moving jib-cranes, which formerly were necessary adjuncts in every machine-shop, we now have high-speed overhead traveling cranes, operated, as a usual thing, by electric motors.

A comparatively small crane of this type (10 tons' capacity) was recently erected in a certain department of a large locomotive works, resulting immediately in a saving of about $100 a day in the work of the department.

In another branch of the same establishment two electric traveling cranes of much larger dimensions were installed about five years ago, dispensing with about 60 helpers formerly required to handle the work.

Recently the superintendent of the locomotive works of a promi-

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* The above data are abstracted from the full and complete report upon watchmaking in Vol. II of the tenth census of the United States.

nent railway company, after a thorough investigation, estimated that the introduction of two 50-ton electric traveling cranes in the shops under his charge would effect a saving of more than $30,000 a year, and, upon the strength of this report, which was practically equivalent to a guarantee on his part to that effect, two 50-ton traveling cranes were ordered, and are now in course of construction.

Assuming that a modern passenger engine weighs about 130,000 pounds and costs about $8000, the cost per pound is less than 6¼ cents. Many readers will remember when the cost of the raw material (chiefly iron and steel) entering into the construction of an engine, was more than this.

The modern flat turret lathe for quickly and accurately cutting screws and bolts from round, square. hexagonal, or other commercial forms of bars without the necessity of preliminary forging to approximate shapes is a notable American labor-saving invention, which, in the hands of an active and intelligent operator, has capacity for large output at low cost. Among the minor economies introduced in American machine shops, the system of having a separate department for the manufacture, care, inspection, and storage of cutting tools, from which they are delivered to the users only on checks, which serve as receipts to identify the person at fault in case of their loss, breakage, or misuse, has been of so pronounced benefit that it has been almost universally adopted. Automatic tool-grinding machines are now provided, by which rough-forged tools are quickly and accurately ground by unskilled labor to standard forms which experiment and experience have proved to be best adapted for the special work they are designed to perform. The quality of work is improved, the output is increased and the cost is reduced by the system.

Foreign engineers and mechanics who have visited American workshops have rarely failed to express astonishment and admiration at the perfection of labor-saving appliances everywhere visible. A report on "America's Industrial Progress" by M. Levasseur (member of the French Institute) in the *Revue Politique et Parlementaire*, attributes the supremacy of American manufactures to the wise economy of "unceasingly replacing out-of-date machines by new and improved types." Several illustrations from personal observation are given, and it is stated that, in one of the largest and oldest establishments of the kind in the United States, not a single ancient machine tool was found working.

Heretofore American manufacturers have been so busily employed in supplying the home demand for their products that the incursions into foreign markets have been only spasmodic, but the time has now come when a concerted effort should, and probably will, be made to exploit systematically the opportunities which have presented themselves, almost unsought, to extend trade abroad in all directions. During the dull times recently some important efforts have indeed been made in this direction, with encouraging result, and, since the recent visit of a distinguished foreign ambassador, Li Hung Chang, some proposals have emanated from that source which are destined to prove of incalculable value to certain American industries. More specific information regarding these facts, which have come to the writer's knowledge, can not be given at present, but will doubtless become generally known in a short time.

It cannot be doubted that the policy which has generally prevailed in this country of employing intelligent mechanics at high wages has stimulated the invention of labor-saving machinery and decreased cost of manufacture; therefore, the proposal at this date to lower the standard of wages in order to compete with foreign manufacturers is a short-sighted and narrow-minded proposition, which would certainly defeat the object in view and ultimately lead to disaster.

Statistics prove that a reduction in wages is always followed by an immediate reduction in consumption, not only of so-called "luxuries," but of all the multifarious manufactures of the country; for the wage-earners are the largest consumers.

Increase of wages and increase of consumption go hand-in-hand, and a period of high wages is synonymous with a period of great prosperity.

A fallacious argument is often advanced to show that high wages are the effect, and not in any respect the cause, of prosperity, but enlightened manufacturers are beginning to take a broader view of the subject, and some of them have already proved, by actual trials, the truth of the propositions here advanced. A few specific instances will be given of these interesting tests.

The president of a large manufacturing company engaged in making a special machine (the "Linotype" type-setting machine), the labor cost of which is said to amount to nine-tenths of the total cost, made the following remarkable statement a few months ago.

His company, he said, has a factory in Brooklyn, and, until recently, had an interest in a factory in Germany, where identically the same machine was built, largely by the same fixtures, tools, and system of manufacture.

Labor in the German factory was about forty per cent. cheaper than in Brooklyn, but the Brooklyn factory produced the machines at a lower cost in dollars and cents.

Other manufacturers have had similar experiences, and M. Mandon, the French engineer, who recently visited this country, stated*

* See *American Machinist*, May 21, 1896.

that exact duplicates of well-known American tools had been made in Paris, but could not be sold there as cheaply as the American tools could be, notwithstanding cost of carriage and the French import duty.

The scientific piece-work system, sometimes called the "differential system," devised by Mr. Fred. W. Taylor and put into practical operation by him at the Midvale Steel works, is a good illustration of the economy of high wages.

This method of remuneration differs radically from the ordinary piece-work system of payment; it makes each workman's interest the same as that of his employer; it pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work.

Briefly stated, the differential system, which has had a test of several years, consists in paying a higher rate *per piece* for a greater amount of work done, without imperfection, within a given time.

The following illustration will show the economy of high wages under the differential-rate system, as applied to turning certain steel forgings, of which many thousands were made.

COST OF PRODUCTION PER LATHE PER DAY.

Ordinary Piece-Work System		*Differential-Rate System*	
Man's wages	$2.50	Man's wages	$ 3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	$5.87	Total cost per pay	$6.87
5 pieces produced.		10 pieces produced.	
Cost per piece	$1.17	Cost per piece	$0.69

These represent actual results obtained in daily work, the difference being due mainly to the differential rate.

This system does not spare the tools, which are run at a high rate, under heavy feed; and, since its introduction, the views of progressive manufacturers regarding the economical use of machine tools have materially changed.

Formerly old tools were venerated and carefully preserved as long as they could be used. Now the aim seems to be to obtain the full life-service in the shortest possible time, and then to consign the tool to the scrap-heap. In this way tools are worn out long before they have become obsolete in design, "soldiering" on the part of operatives is effectually eliminated, the output is increased, and cost of production is decreased in an astonishing ratio.

Recently a practical illustration of this subject, from the operatives' standpoint, came to the writer's knowledge.

A skilled lathe-hand, who had been employed in one establishment for several years on one kind of work, went to another shop, where he was offered twenty-five per cent. more pay per piece for precisely the same job; he soon found that, owing to the continued use of an antiquated lathe in this establishment, and consequent smaller output, he was unable to make as high wages as he did at the former place of employment, although far more care and attention on his part were required to avoid errors in sizes, all of the pieces being fitted to standard gages.

Mr. Hiram S. Maxim, the well-known inventor, established extensive machine shops in England a few years ago, and found that English machine tools were old-fashioned and English operatives inefficient. He thus describes his experiences: "When I first came to England, wishing to buy some lathes, I examined a large number by different manufacturers, and was surprised to find how old-fashioned they were. . . So, when I had to equip some very large factories, I found it to the advantage of my companies to purchase the greater part of the tools from American makers." Having obtained American tools, Mr. Maxim then encountered a serious difficulty in securing competent operatives, and, furthermore, he found that American automatic machines, several of which are commonly placed in the charge of one workman in the United States, must be run singly in England. "This is due to the influence of the trade unions. These associations control the men in England to such an extent that they dictate how many machines the men shall run, and, except in special cases, they refuse to allow one man to take charge of more than a single piece."

Finally, as a result of a strike at the Maxim-Nordenfeldt gun factories, previous to which many of the union men not only objected to work more than one milling machine, but wanted the company to agree not to allow any non-union men to operate more than one, unskilled men were placed in charge of the milling machines, and in a short time one such man was able to operate four machines where a union man had run only one.

These illustrations might be extended and elaborated, but, even when thus briefly stated, they serve to emphasize the general statement that labor-saving machinery, while, in one sense, a competitor of hand labor, is, in another and larger sense, its most efficient handmaiden, or help-meet; not only has labor-saving machinery decreased cost to the consumer, but it has increased wages of operatives and decreased manual toil. It has been the means of substituting intelligence for brute strength, and has, in all respects, proved the friend of labor.

In a former paper, in this magazine,—one of a series,—the writer said: "The introduction of labor-saving machinery has enormously increased the output for each workman, and this introduces a new element into the ethics of the question of wages, and also into the practical question of cost. If it can be shown that a skilled workman, at a slight increase of labor and attention, can enormously increase the output of a machine, he should be encouraged to make the effort by an increase of pay ; an increase of output must logically and necessarily involve a corresponding and fair increase in wages.

"Hence increase of output necessitates increase of wages, and, in a properly-conducted business, this increase of wages, following increased output, must mean increased profit. This is a profit-sharing scheme to which there can be no practical objection."

The conclusion to which the arguments and illustrations here given lead are :

I. The true policy of the employer of labor is to encourage the brightest and most inventive workmen by liberality in the wage-scale, and to stimulate the improvement of all mechanical methods and appliances in order to continually increase the output for each man and each machine in his establishment.

II. The true policy of the employee is to use his best powers of mind and body to obtain from the improved machines the maximum output, with minimum errors, and thus to secure maximum wages.

When these policies shall have become universal principles, actuating employers and employees alike, there will be no reason why this great country should not, in accordance with Mr. Atkinson's forecast, gain the paramount control of the commerce of the world.

This is surely a prize worth striving for, and can be gained only through the harmonious and intelligent coöperation of capital and labor.

THE RISE OF THE YOUNG GIANT, COMPRESSED AIR.

By Curtis W. Shields.

GENERAL HERMAN HAUPT, writing in THE ENGINEERING MAGAZINE in August, 1892, used the significant sentence: "The fact that pneumatic motors, after a successful demonstration of their superiority, have been largely overlooked seems inexplicable." This comment was made in immediate connection with the subject of motors for street-car propulsion, but General Haupt had no limited conception of the certain future for compressed air.

The importance he attached to it as one of the great rising agents in power application and power transmission is most clearly demonstrated by his criticism of the proposed and since completed electrical-power station at Niagara. The late Franklin L. Pope, in THE ENGINEERING MAGAZINE for December, 1895, quotes him thus: "General Haupt, however, ... boldly takes the ground that the attempted employment of electricity for the distribution of power from Niagara is an engineering mistake, and contends that the only economical and commercially-feasible plan is that which depends upon the use of compressed air."

Such faith was remarkable, but strongly founded. Rapidly making its way under the trying, but infallible, test of competition, compressed air has risen above the need of any apologist, and stands now as one of the most efficient agents in putting our shops, our industries, and our manufactures on that basis of economy and efficiency which is the essential forerunner of prosperity. But, while one of the newer agencies in its effective application, it is far from new historically.

Authentic records antedating 250 B. C. show conclusively that Ctesibus of Alexandria accomplished the harnessing of that omnipresent and irresistibly powerful element, the air, and among other uses applied it to a kind of air-gun which projected an arrow a considerable distance with great force and accuracy. At first thought it appears strange that greater progress has not been made in a science of which at least something was known so many centuries ago, and the possibilities of which have been continuously impressed upon each individual (at the rate of 14.7 pounds to the square inch) ever since.

There has been, of course, a gradual progress both in the application and in the generation of compressed air for centuries, but it made but little real headway prior to its adoption by Prof. Colladon, of Geneva, as a motive power for operating the machine-drills in the famous Mont Cenis tunnel. In America the first practical use of compressed air on a large scale was at the Hoosac tunnel. The compressor for this work (Fig. 1) was built just prior to 1866 from designs of Mr. Jno. W. Brooks, chairman of the Massachusetts State Commission, and Mr. Thos. Doane, chief engineer for the tunnel construction. After the completion of this tunnel, this compressor was moved to Proctor, Vermont, where it has been in use ever since, compressing air to a pressure of about three atmospheres to the square inch. This air is used for operating channeling machines and rock drills of modern construction, which have revolutionized the method of quarrying.

In the arrow-throwing gun of Ctesibus, the ancient air mattress (Fig. 2), and the compressor used at the Mont Cenis tunnel (Fig. 3) we find the prototypes of the present pneumatic dynamite gun (Fig. 4) now in use by the Cubans; the sleeping-car equipped with pneumatic chair-seats, pillows, and mattresses inflated by compressed air supplied from the air-brake pump on the engine; and the cross- compound condensing Corliss compressor plant (Fig. 5), now used in

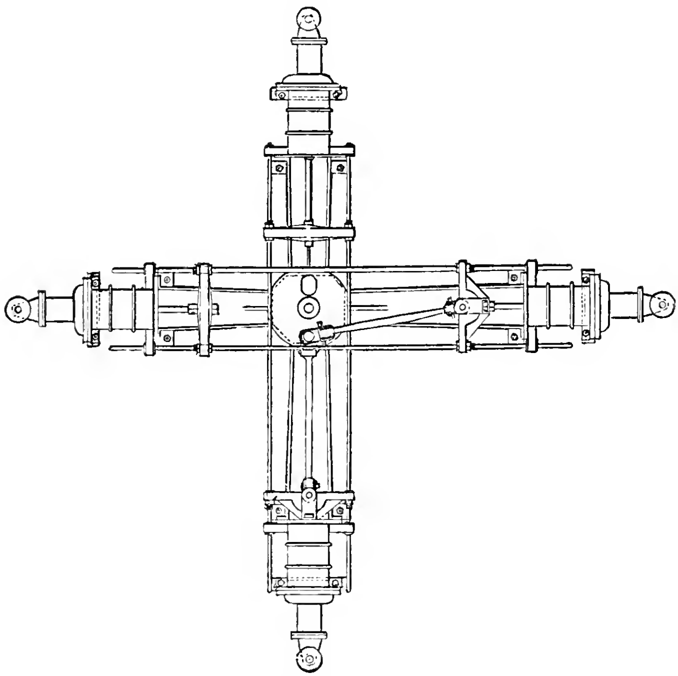


FIG. I. THE COMPRESSOR USED AT THE HOOSAC TUNNEL.

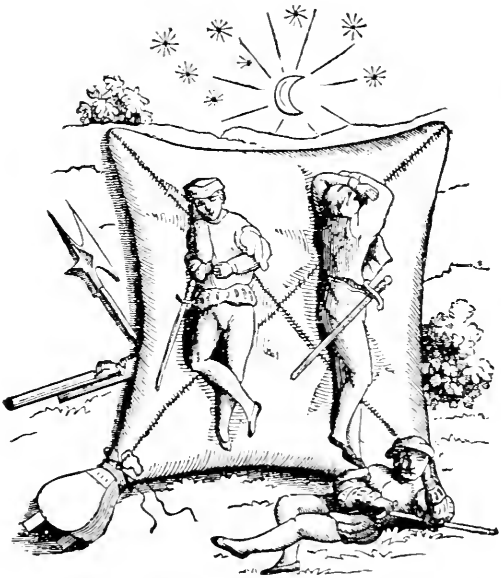


FIG. 2. AN ANCIENT AIR-MATTRESS.

operating the machinery employed in excavating the colossal reservoirs at Jerome Park, which are designed to supply potable water to the city of New York. Again the air-lift pump of to-day, for deep wells, shows the evolution of Hero's Fountain, a pneumatic experiment familiar to all students of natural philosophy. The pneumatic tube system for the conveyance of parcels or mail matter, such as is shortly to be installed to connect the New York and Brooklyn post offices *via* the Brooklyn bridge and the Pennsylvania & Reading terminals with the Philadelphia post office, had its origin nearly two centuries ago in the fertile brain of Dr. Denys Papin, of Blois, France.

In 1869 George Westinghouse produced his first air brake, the de-

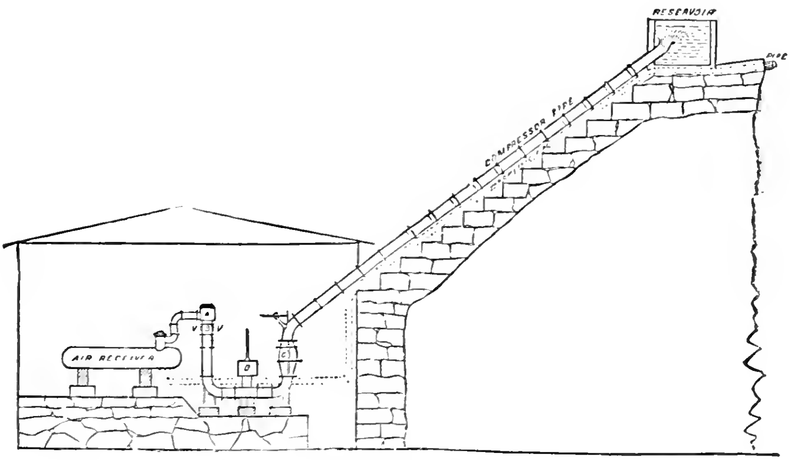
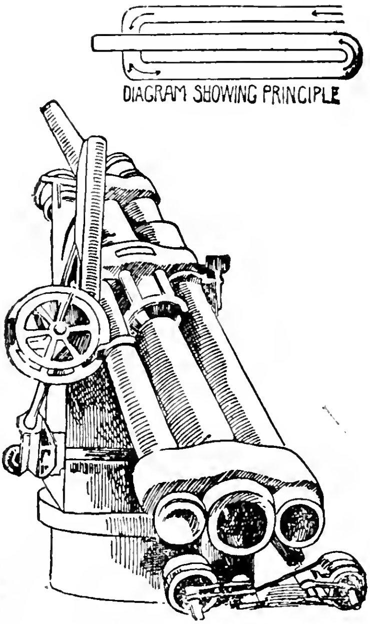


FIG. 3. COMPRESSOR USED AT THE MT. CENIS TUNNEL.



DUDLEY PNEUMATIC GUN.
FIG. 4.

velopment of which, known as the "automatic brake," has materially reduced the danger of accident in railroad travel. It was not until the latter part of 1887, however, that he succeeded in constructing the present quick-acting, automatic brake, which operates under all conditions of practical railway service. Next in importance to the air brake in railway service is the operating of switches and semaphore signals. Here again compressed air is the factor that plays the all-important part. On the Harlem division of the New York Central & Hudson River Railroad compressed air for these purposes is carried through pipes from Mott Haven (One Hundred and Thirty-eighth street) to White Plains, N. Y.,—a distance of seventeen miles. Another branch pipe to Woodlawn—a distance of six miles—conveys air to move an ordinary

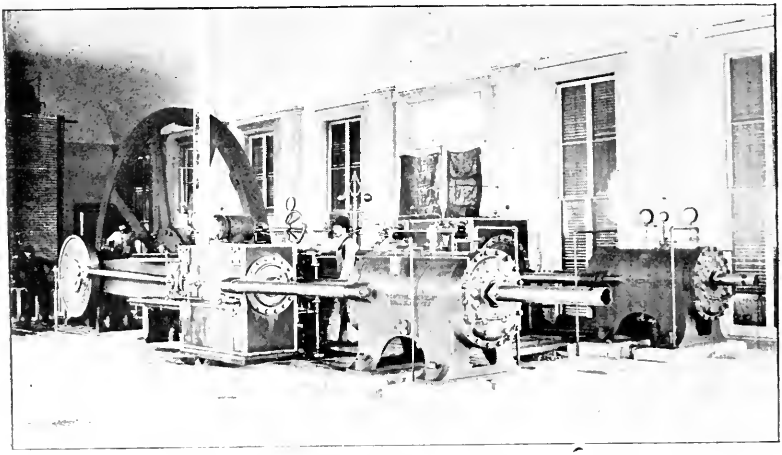


FIG. 5. A MODERN AIR-COMPRESSING PLANT.

engine which drives the dynamo supplying the electric current necessary for this signal system. Indeed, railway work seems to excel any other branch in the diversity of uses found for compressed air. It serves to signal the engineer, to ring the bell, to sand the track, and even to dust the cushions, clean the hangings, and raise the water in the lavatories of the sleeping-car; and in the shops it lends itself with equal readiness to heavier duties.

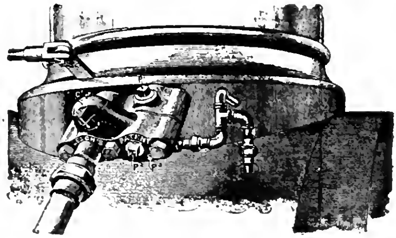


FIG. 6. PNEUMATIC TRACK-SANDER.

A sand-papering machine made up of a framework on which is mounted a disc covered with sand paper revolving at a very high rate of speed does the work of six good carpenters, and, operated by one man, finishes the surface of a baggage car, making it ready for the painters, in fourteen hours.

A portable pneumatic saw for cutting off the ends of the boards on freight-car roofs trims off both sides of a thirty-four-foot car in six minutes. Likewise a machine for planing floors or decks of ships is driven by a rotary air motor mounted on what seems at first glance to be an ordi-

FIG. 7. CLEANING CAR CUSHIONS WITH AIR.

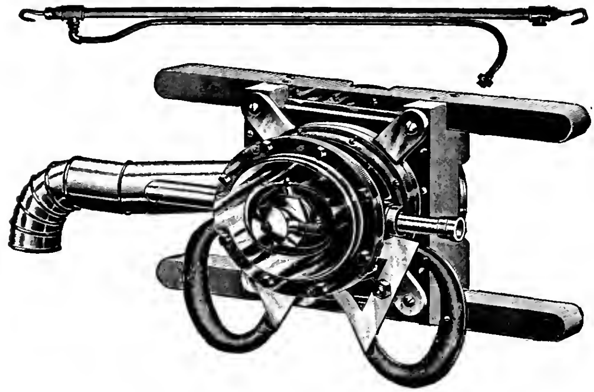


FIG. 8. SAND-PAPERING MACHINE OPERATED BY COMPRESSED AIR.

nary lawn-mower. The round-house turn-tables, for shifting locomotives, are in many cases actuated by air power. Fig. 14 shows the air cylinder located at the base of the pit and operated by allowing the air to enter either end, as may be desired. The piston forces a rack along, thus turning a pinion that swings the turn-table to the desired position.

A steel ditcher, scraper, and excavator operated by compressed air is now used for grading road-beds and making ditches for draining the same. This ditcher is composed of a heavy steel frame platform car forty-six feet long, on which is mounted a derrick having a swing of fourteen feet. The hoisting and lowering apparatus is worked from an air cylinder attached beneath the car. This derrick and hoisting attachment is used for adjusting and keeping at a proper height all the tools for ploughing, excavating, leveling, ditching, or grading, as well as for loading and unloading all tools and machinery from the car.

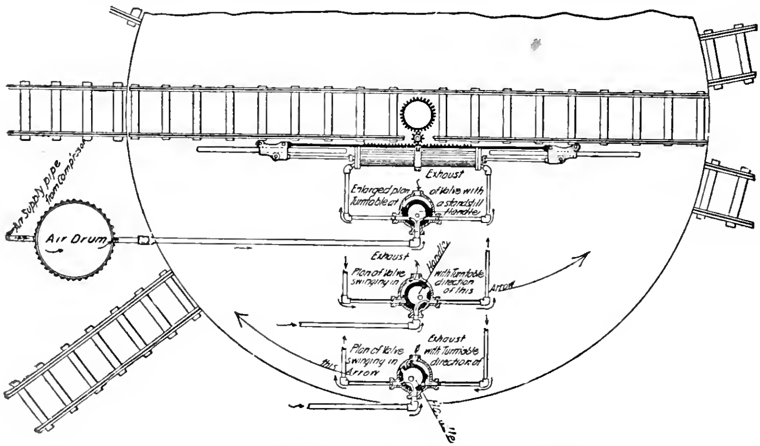


FIG. 9. PNEUMATICALLY OPERATED TURN-TABLE.

The air-using appliances are all operated by a man stationed at the base of the derrick, by means of three four-way cocks. The plough, proceeding at the rate of four miles per hour, will cut a furrow twenty-nine inches deep by thirty-six inches wide. This outfit (Fig. 10), will perform work in one day at a cost of less than $20 which would cost not less than $500 by former methods.

All kinds of painting where large surfaces have to be covered, as is the case with freight cars, buildings, bridges, and ships, may be done by compressed air, which blows on a spray of paint and penetrates interstices much better than the hand can do it. Much time is saved, and the necessity of costly brushes, skilled labor, and scaffolding is done away with.

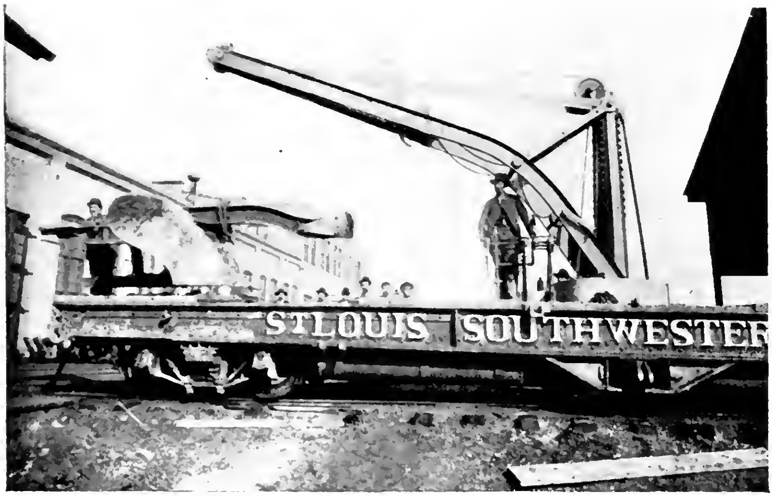


FIG. 10. PNEUMATIC DITCHING AND GRADING MACHINE.

At the present time the use of compressed air for street cars is exciting the greatest attention. Trials of these cars under actual working conditions are now in progress both on surface and elevated tracks in New York, Chicago, and Washington. The compressed-air motor-car shown in Fig. 11 has been in successful operation on One Hundred and Twenty-fifth street, New York city, for several months, making in daily service seventeen miles without recharging, under the identical conditions met by trolley or cable service, and has conclusively demonstrated its ability to meet all requirements. In fact, the makers of these cars guarantee that a line equipped with them can be maintained and operated at a cost per car mile not exceeding that re-

FIG. 11. COMPRESSED-AIR STREET CAR, IN SERVICE IN NEW YORK.

quired for overhead trolley service under precisely the same conditions. Economy of operation is the crucial test from the standpoint of the traction companies. The features that appeal most to the passengers and the public in general are the doing away with poles, overhead wires, and the continual excavating for cables, pipes, or conduits. No fatal accidents from live wires ; no obstructing the efforts of the fire department in moments of danger to life or property ; no possibility of stalling on railroad crossings in front of approaching trains ; no obstructing of the running of the cars by tampering with the source or conductor of power during riots or strikes ; and no electrolysis of water- and gas-pipes by escaping currents.

Compressed air at high pressure (2,000 pounds) is stored in Mannesmann steel bottles located under the cars. There is no danger connected with the use of this tremendous pressure, for the method of making these reservoirs and the composition of the metal prevent all possibility of injury to passengers, even if an explosion should happen. At a recent test to destruction by hydraulic pressure one of these bottles broke at a pressure of 5,760 pounds to the square inch. A crack or split about 2½ feet long opened on one side, but not even the smallest particle of the metal flew, and a crowd of interested spectators standing from three to ten feet away were entirely unharmed. As the greatest pressure is put on these reservoirs at the instant the charging is finished, and as the pressure is gradually reduced as the car goes on its journey, there seems to be little likelihood of even a harmless explosion while passengers are in the car.

In mining operations compressed air has long been used for running pumps, drills, coal-cutters, and locomotives. In coal mines which are troubled with gases, lumber yards, powder mills, and the great cotton wharves and warehouses of the south, the compressed-air locomotive has a special field of usefulness on account of the necessity for extra precautions against the risk of fire. A locomotive of this type (Fig. 12), having a capacity of 580 cubic feet, can be charged in one and one-half minutes to a pressure of 600 pounds to the square inch.

In mines the exhaust air from the various machines serves a useful purpose in ventilating and cooling the workings.

It was largely owing to the use of compressed air as a motive power for excavating-machinery that so gigantic an engineering feat as the Chicago drainage canal was made possible at a reasonable cost.

This tremendous undertaking involved the excavating of a channel 160 feet wide and 35 feet deep, containing 12,071,668 cubic yards of solid rock. On this work no less than fifteen air-compressors were employed.

It impressed one with feeling that can best be described as *uncanny* to see dozens of powerful drills, huge channelers, pumps, and hoists handling large quantities of material with no visible indication of a motive power. The quantities of exhaust steam usually so much in evidence were here almost entirely absent, giving an air of mystery to the whole operation ; and it seemed to the uninitiated observer as if no actual work was being done.

One of the greatest strides toward the goal of perfection was made when it was determined that compressed air could be advantageously used in the building of large high-level canal locks. This simple contrivance, which is designed for installation at Lockport, N. Y., will, it is estimated, take the place of the sixteen locks now used at Cohoes, and at one operation boats will be raised to a height to which they could previously be raised only by sixteen locks. The immense saving in

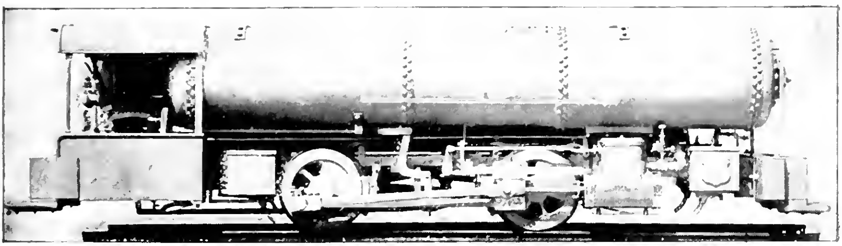


FIG. 12. DOUBLE-TANK COMPRESSED-AIR LOCOMOTIVE.

cost of construction and time of operation can be readily appreciated.

The principle on which these locks work may be best described by the following simple experiment. Take two tumblers and fasten their bottoms together; you will then have a representation of one section of these locks. Partially fill the upper tumbler with water, and place both in a basin or tank of water with the empty tumbler open end downward. With a tube blow air into the lower tumbler until it almost rises clear of the water. A second pair of tumblers similarly arranged will represent the other section of the air lock. Connect the air spaces of the two bottom tumblers by means of a tube, and, thus balanced upon the compressed air, both sets of tumblers rise or fall, and air is made to flow from one tumbler to the other through the connecting tube or pipe.

This principle has also been applied to dry docks for repairing vessels, and has many advantages over the ordinary type of off shore docks now in use.

But for compressed air, it would be almost, if not quite, impossible to obtain suitable foundations for the mammoth sky-scraping structures which stand out so prominently in lower New York. In this foundation work, both for buildings and piers for bridges, caissons have to be sunk gradually, as the excavation progresses. Compressed air is used to keep the working chamber at the bottom from

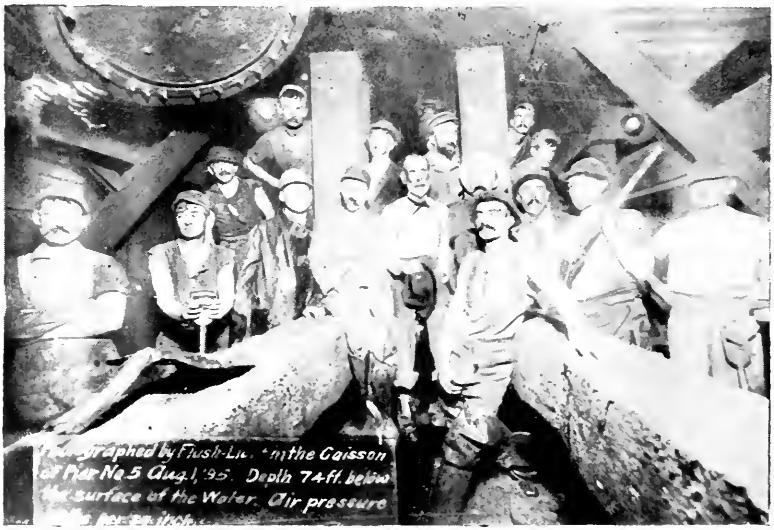


FIG. 13. INTERIOR OF A CAISSON, 74 FEET BELOW WATER-LEVEL.

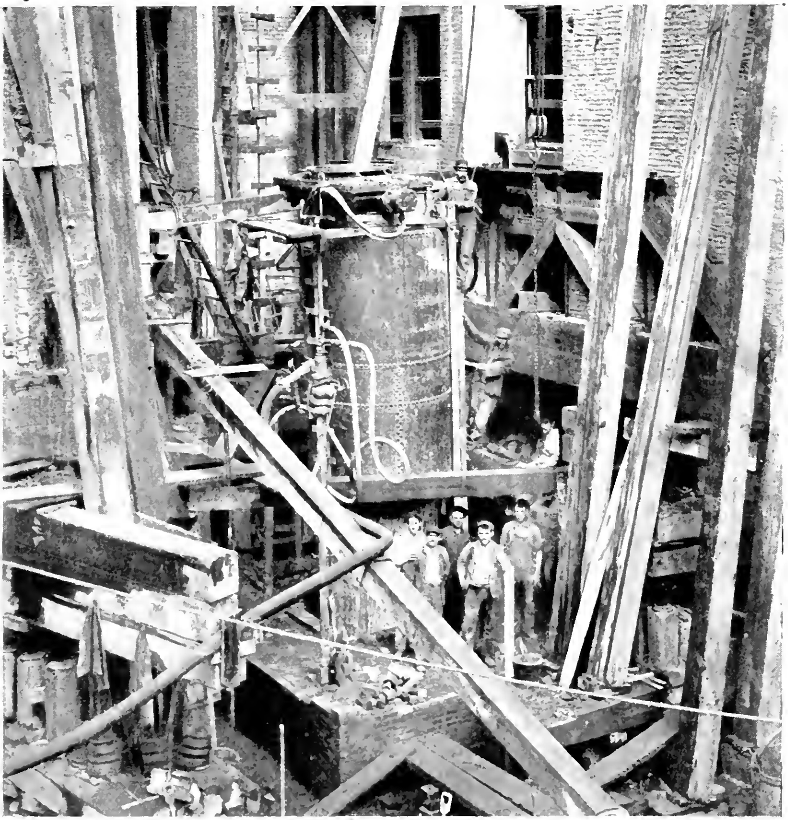


FIG. 14. COMPRESSED AIR IN FOUNDATION WORK. SINKING A CAISSON FOR THE FOUNDATION OF THE AMERICAN SURETY BUILDING, NEW YORK CITY.

being filled by the water and soft earth or mud that otherwise would prevent the men from working. It also operates the rock drills, and serves to ventilate the caisson work. With proper precautions a perfectly healthy man can work under an air pressure of seventy-five pounds per square inch, though forty pounds is rarely exceeded in ordinary work.

In wrecking operations compressed air is employed to force out the water from numerous barrels or bags which are attached by divers to a sunken vessel, thereby furnishing the buoyancy necessary to bring the vessel to the surface.

The use of compressed air on board the United States monitor "Terror," for turning the turrets, working the guns and ammuni-

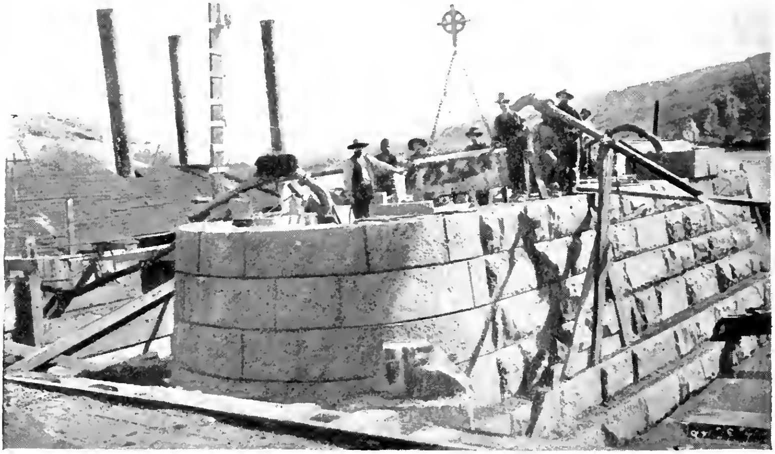


FIG. 15. COMPRESSED AIR IN BRIDGE WORK. BUILDING PIER OF CANTILEVER BRIDGE AT THE NEEDLES, CAL., ON A CAISSON SUNK 64 FEET BELOW WATER LEVEL.

tion hoists, and operating the steering gear, makes this floating engine of destruction one of the most notable vessels in our navy. (Fig. 16.)

The whole stone trade, from the first operation of quarrying to the finished carvings, has been revolutionized by the use of compressed air. In fact, the introduction of air-operated machinery is about the only marked improvement in handling stone that has been brought forward since the stone age. The channeling machine cuts out blocks in the hard unyielding masses of stone in much the same manner as we cut squares of cheese with a knife. This process obviates the use and expense of explosives and the enormous waste of material, inseparable from blasting. All the finest carvings, tracery, and lettering on both building and monumental work is done by means of a small pneumatic engine weighing about two pounds, held in the hands of the workman. This machine comprises a cylinder or shell six inches long, which contains a solid piston or hammer reciprocating very rapidly and striking the end of the chisel about ten thousand blows per minute. As a man cannot swing a heavy

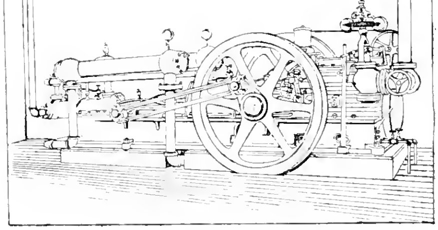


FIG. 16. AIR-COMPRESSOR PLANT ON THE U. S. MONITOR TERROR.

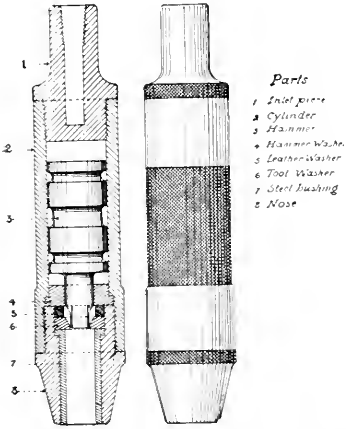


FIG. 17. PNEUMATIC STONE-CARVING TOOL.

hammer continuously more than thirty times per minute, one can hardly imagine the great increase in the capacity of a skilled artisan equipped with one of these handy little tools (Fig. 17).

In nearly all manufacturing and mercantile pursuits more or less lifting of goods is necessary. For hoisting purposes compressed air is unrivalled, both in speed and cost. Sufficient air can be obtained at an expense of 3½ cents (for compressing) to lift a weight of 2,500 pounds four feet *one hundred times*. Such a hoist (Fig. 18) is a very simple contrivance, being nothing but a cylinder, made of a section of pipe closed at both sides and fitted with a piston whose rod, terminating in a hook, projects through a stuffing box in the bottom cover of the hoist. Air is admitted through a flexible-hose connection to the lower side of the piston, and lifts whatever weight may be attached to the hook. By suspending these hoists from an overhead track, goods can be transported to any part of the establishment. This method has an advantage not possessed by an overhead traveling crane,—*viz.*, that it can extend its field of usefulness

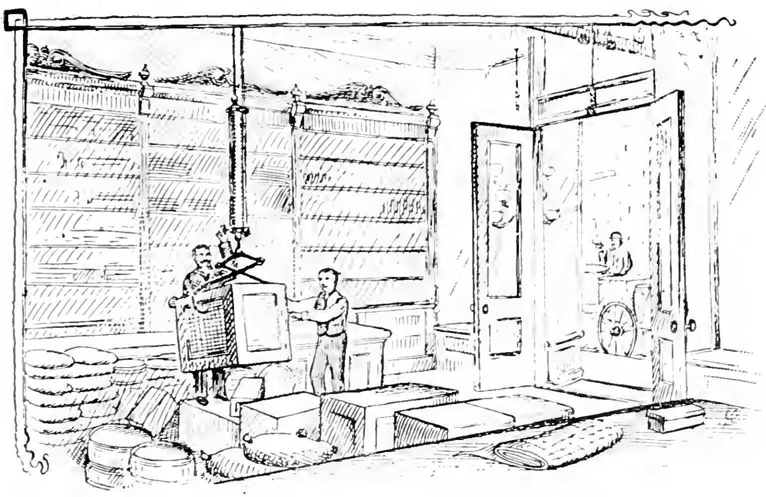


FIG. 18. COMPRESSED-AIR HOIST IN A WAREHOUSE.

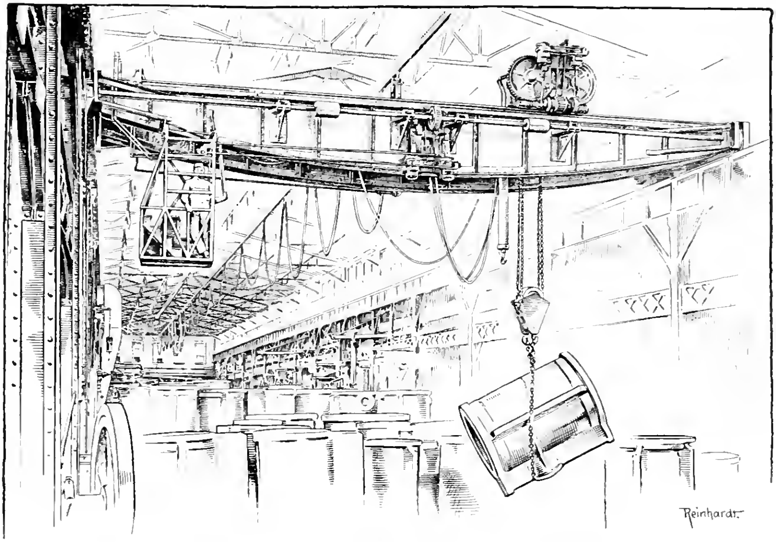


FIG. 19. COMPRESSED-AIR TRAVELLING CRANE, 20 TONS CAPACITY.

beyond the confines of the shop in which it is located, and can follow the track and transport its load to any desired point.

In order to do this, hose connections are used similar to those employed on trains for coupling the air-brake pipes between the cars. A hoist is made, the pipe disconnected, and the load transported. In stores heavy boxes, barrels, etc., can be readily picked up by an air hoist and loaded upon a wagon by one man in less time than it could be done by several men using less modern methods. By an actual test a weight of one ton was lifted and transported a given distance in one ninth the time required to operate an ordinary differential-chain hoist of the most improved type.

Where the head-room will not permit the use of the pendant direct-acting hoist, a rotary air motor is attached to a differential hoist in place of the usual endless chain.

Large traveling cranes actuated by compressed air are used to great advantage in foundries where the dust and heat are so detrimental to electric motors as to render them inefficient and a continual source of annoyance through stoppage or breakdowns (Fig. 19).

Portable pneumatic riveters have supplanted both hand and hydraulic work, and not only operate more economically, but, on account of their light weight, can be handled more quickly; moreover, the number of rivets driven per day is largely increased (Fig. 20).

In confined spaces where it is impossible to drive rivets in any other way than by hand it frequently is a problem to determine how to back up or "hold on" a rivet while it is being hammered into place. The little air ram (Fig. 21) comes to the rescue, and provides an elastic wedge, or backing, that enables the men to speedily drive the rivet.

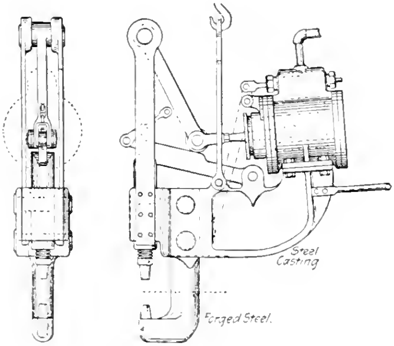


FIG. 20. PNEUMATIC RIVET DRIVER.

In the machine shop, or on work where the holes have to be drilled and where it is impracticable to use an ordinary drilling-machine, the pneumatic breast drill (Fig. 22) puts in the required hole while held in the hands of a workman. This little tool, weighing 18 pounds, with 80 pounds of air pressure will drill a $\frac{5}{16}$ inch hole through cast iron one inch thick in one minute. It is especially useful for centering and counter-sinking lathe work, drilling holes for tap bolts and screws, or grinding-in valves.

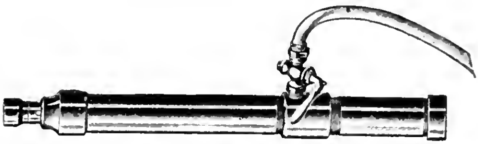


FIG. 21. RIVET HOLDER-ON.

The reamer (Fig. 23) has revolutionized the methods of reaming the rivet-holes and the tapping and insertion of stay-bolts in boilers.

In the use of heavy lathes, planers, or other large shop tools much annoyance and loss of time results from the difficulty experienced in shifting belts. A compressed-air belt-shifter designed by some ingenious mechanic made this trouble a thing of the past. Many machine shops now use compressed air for so many important operations that a stoppage or breakdown of the air machinery is a very much more serious matter than if the shop engine were to be suddenly placed *hors du combat*. In

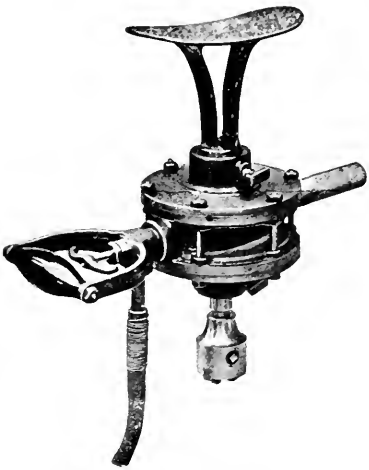


FIG. 22. AIR-DRIVEN BREAST-DRILL.

the latter event the major portion of such a shop would be driven by compressed-air engines mounted on small trucks, as is often the case in overtime or Sunday work. But, if the compressed air supply should cease, the hoists and other air-using apparatus would be inoperative, and, as other means of performing this duty have been discarded, the shop would have to shut down.

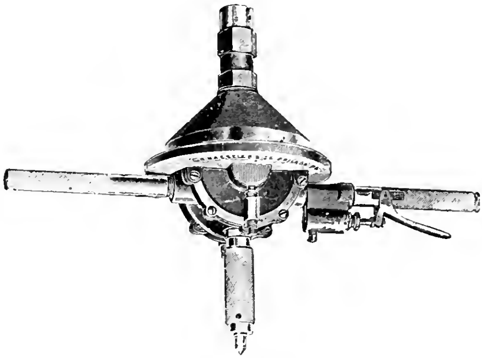
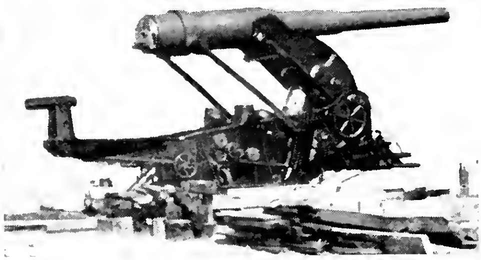


FIG. 23. AIR DRILL AND REAMER.

In foundries compressed air operates hoists and traveling cranes; molding machines which, in the hands of an unskilled laborer, turn out more and better work than could an expert molder at double the wages; sand-blast machines, by means of which compressed air blows a jet of sharp sand against the castings as they come fresh from the molds, and thoroughly cleans every particle of sand, scale, or core from the casting, leaving it with a bright grey polish that is impossible of imitation by hand. These machines use the sand over and over again, automatically, until every particle of it has been used up or ground to powder. The operator merely has to direct the hose nozzle against the core, whereupon sand sticking to the casting and all the dirt and dust are drawn down through grate-bars in the floor by an exhaust-fan system. The core irons fall into a bin, or pocket, from which they are readily removed for use again. The fine dust is blown outside; and the sand is sifted or screened, and carried up overhead, whence it is fed by gravity back into the sand-blast machine, ready for use.



DISAPPEARING GUN, PNEUMATIC CARRIAGE.

The time-honored screw-press for copying letters has been supplanted by a compressed-air ram, which presses the copying-books much more forcibly and quickly than can the hand, all the muscular effort required being that incident to the turning of a small valve. Office-buildings are now being fitted with a compressed-air supply for the convenience of tenants. The Havemeyer building in New York has air pipes led up through the pipe-shaft with branches at each floor, and the convenience of an air-supply for dusting and cooling the offices influences prospective tenants when seeking a new location.

Few of us know that the modest bundle of kindling wood purchased at the corner-grocery is pressed into its small compass ready for the binding-twine which holds it together by a compressed-air ram. Dozens of these presses are located in long rows on the sides of large tables, upon which piles of the small sticks are heaped. Girls with deft fingers quickly gather the wood into the compress, and, while the air pressure is holding the bits of wood closely together, the girdle of twine is slipped on.

Of the smaller adaptations of this convenient agency, as in bicycle motors, and of the uses which are not properly in the field of power, as the preserving and refrigerating of perishable products, it is not necessary to speak here. It is desirable, however, to impress the point that compressed air and electricity work in the utmost harmony, and are not the competitors that they are commonly supposed to be. Usually each performs duty for which it is so preëminently fitted that there can be no question of competition. Compressed air cannot be used for lighting; neither can electricity be used to advantage to operate a brake on a train. They are both means of power transmission, but, when it comes to the actual application of the power, each has its own fields. One great advantage of compressed air is that it is entirely harmless in the hands of inexperienced persons. No special knowledge or training is necessary to enable the ordinary mechanic to operate compressed-air machinery. As the artisans in the various trades become more and better acquainted with the ease with which air can be applied to their work, the inventive genius which is so thoroughly a part of the American workman's stock in trade will find numerous applications for this most tractable of servants, and we can expect to learn at no distant date that a company such as exists already in Paris has started to furnish compressed air for domestic use here. No doubt, before the end of the next decade, we shall have our refrigerators cooled by compressed air, and the thrifty housewife will run the sewing machine, rock the cradle, and dust the furniture from the same hose-pipe.

THE PRESENT AND FUTURE OF AMERICAN RAILROADS.

By Thomas F. Woodlock.

THE most important manufacturing industry in this country is that of railroading. Out of labor and material the railroads manufacture transportation, which they sell to the public. The value of their product is far in excess of one billion dollars annually, and the plant from which this is produced now comprises (exclusive of street railroads) 180,000 miles of railroad, or about one-half of the railroad mileage of the world. The manufacture of transportation gives work directly to about one million men, and at least three millions to four millions are directly dependent upon the railroads for support. The wages bill of our roads probably approaches half a billion dollars annually, in addition to which they spend about two hundred and fifty million dollars for material, such as fuel, steel rails, lumber, etc. There is no industry in the country that approaches transportation in importance, and no interest exceeds it save that of agriculture.

We are apparently on the threshold of one of those periods of activity, recovery, progress, and expansion that men speak of afterwards as "good times," though they sometimes fail to admit the existence of the "good times" while they last. Assuming this, it is surely important to find out where stands our great railroad estate, and what it has to expect from the future which looms so bright for every one. Let us, as a preliminary, consider a few facts of history.

Last year (1895) 179,000 miles of road took in from the public, in one shape or another, $1,093,139,605 as gross earnings. This resolves itself into $6,101 per mile of main track. The cost of doing this business, including taxes, absorbed $769,943,151, or $4,297 per mile, leaving the net earnings $323,196,454, or $1,804 per mile. If we assume that operating expenses include everything required to conduct transportation and fully maintain plant, these net earnings represent the profit accruing to our railroad estate, from its own business,—that is, strictly railroad business.

The sum of $323,196,454 is equivalent to 6 per cent. interest on a sum of $5,386,609,100, which, in turn, is equivalent to a capitalization of almost exactly $30,100 per mile of main track, fully equipped and with terminals. The nominal capitalization of the railroads, however, at the end of 1895 was $60,835 per mile, on which last year net earnings represented less than 3 per cent. It may be proper to say that, while our railroad system may have originally cost a good deal less than $60,000 per mile to build, with equipment, terminals, etc., complete, its actual value to-day, if measured by no other standard than the cost of duplication, is decidedly greater than $30,000 per mile. Indeed, much of it simply could not be duplicated ; for example, the terminal facilities owned in such cities as Philadelphia, Chicago, Boston, St. Louis, St. Paul, Kansas City, and the other great cities in this country, where real estate is sold by the foot and almost by the inch.

However, we are considering facts as we find them. We find that in thirteen years—to go no further back—gross earnings per mile of road have fallen from $7,461 to $6,101, and net earnings from $2,702 to $1,804. In this period the railroad system of this country has grown from about 107,000 miles to 179,000 miles of main track. The decrease in gross earnings per mile in this period is $1,360, of which $894 is accounted for in freight earnings and the balance in passengers. The net loss is $898 per mile, as the saving in operating expenses was only $462 per mile. Thirteen years ago, however, the number of tons carried for each mile of road was 3,744, whereas last year it was 4,263, so that 4,263 tons last year produced $894 less gross revenue per mile than did 3,744 tons thirteen years ago. Where a ton of freight produced $1 thirteen years ago, it produced only 68 cents last year, other things being equal. Putting it in another way, where the railroads hauled a ton of freight 81 miles for $1 thirteen years ago, they hauled it 119 miles last year for the same money. Thirteen years ago the railroads carried 2,923 passengers for each mile of road, and last year they carried 3,036, but the 3,036 carried last year paid the railroads only $1,460, while the 2,923 carried in 1883 paid $1,934. Where, therefore, a passenger paid $1 thirteen years ago, he paid only 85 cents last year ; last year the railroads carried a passenger 48 miles and a fraction for $1, while thirteen years ago they carried him for the same money only 41 miles and a fraction.

The price of passenger transportation, therefore, in thirteen years has fallen 15 per cent., and the price of freight transportation has fallen no less than 32 per cent. If, then, the railroads had been able to obtain on last year's business the rates for transportation which ruled thirteen years ago, they would have received $46,000,000 more revenue from passengers and $350,000,000 more revenue from freight, which would have meant $396,000,000 additional net revenue, assuming that it cost no more to do the business than it did. Sticking, however, to facts, we find that each dollar of railroad revenue last year was composed as follows :

Passenger revenue, including mail, baggage, etc.	32 cents.
Freight revenue........	68 cents.
Total.........	$1.00

from which we see that the price of transportation generally (on last year's basis) has fallen over 27 per cent. in thirteen years.

Competition between the railroads themselves, born of speculation; competition incited by depression, with the weaker railroads driven by the stronger, which are then in turn driven by the insolvent; competition fostered, and almost forced upon the roads, by State and federal legislation; competition of waterways with railroads; competition, most of all (as Vice-President Clough of the Great Northern has pointed out), of region with region, and producer with producer,—all these kinds of competition have been aided and abetted by the efforts of a few railroad managers to cheapen the cost of production, these efforts, where successful, lowering the price for all competitors.

In practically all industries other than that of railroad transportation the law of supply and demand holds good, together with the law that the margin of profit cannot be reduced below a certain point without checking production. There is always a point where competition ceases to be profitable, and the weaker go out of business, ceasing to produce. When pig iron falls below a certain price, a very large number of blast furnaces go out of blast; coal mines are shut down, when coal falls in prices and operators can no longer make money; cotton mills shut down, when print cloths fall below a certain price; and the result is that the production of all these things is diminished, which in time remedies the decline in price.

This is not so with the railroads. Once built, a railroad practically never ceases operations. The smaller the margin of profit in the business, the greater the necessity for increasing the volume of business, and the greater the competition for whatever business is offering, thus still further diminishing the margin of profit. This is the experience of all railroads which have had to compete with bankrupt properties. Roads in receivers' hands, with no fixed charges to meet, are, as all railroad men know, frequently most aggressive competitors, although they are admittedly in receiver's hands because they could not pay their way.

With competition growing all the time under these most favorable circumstances, and without the operation of any natural law or compensation shutting off the production of transportation after a certain point, there has been in force a stringent law designed to remove the only protection at the command of the railroads and leave them practically helpless. Without attaching as much blame to the interstate commerce law and its anti-pooling clause as many railroad men do, it must be said that it has unquestionably aggravated the present trouble.

Thirteen years ago the railroad had to spend 68.78 cents out of every dollar they received for furnishing transportation, and each "revenue train-mile" run cost them 95.75 cents. Last year they spent 70.43 cents out of every dollar earned, and each "revenue train-mile" cost them 93¼ cents. In 1883 each "revenue train-mile" produced $1.50, while last year the return was only $1.33⅓. Of the gross loss of 16⅔ cents per "revenue train-mile" there remained as net loss about 14 cents, the saving in expenses being only 2½ cents.

Now, the actual railroad service performed in running a train-mile thirteen years ago was not very different from that involved in the same operation last year. In 1895 each freight train had a few more cars than in 1883, but that was about all. As far as the railroad companies themselves were concerned, there was not much difference in outlay. The additional cars called for more switching and more handling, but one engine could haul them with almost no increase in cost. Remembering, moreover, that a large proportion of a railroad's operating expenses is not at all dependent upon train-mileage, while another large proportion is only indirectly dependent thereon, it is clear that the physical service performed by railroads—measured by the unit of that service, the train-mile—certainly cost at least as much last year as it did thirteen years ago, and probably more. With an increase of 52 per cent. in train-mileage the decrease in the expenditure per train-mile is only about 3 per cent.

The reason is that, *while there has been a general decline in the price of transportation in thirteen years of 27 per cent., the raw material from which transportation is manufactured has certainly not declined in price as a whole. This raw material is composed as follows: labor, 60 per cent.; material, 40 per cent.;*—a rough division, but sufficiently accurate for our purpose.

There has been, undoubtedly, a large advance in the price of railroad labor in the period, considering all classes of employees. It is hard to estimate it very closely, but the evidence is all in that direction. The chief requisites of railroad-supply stock, such as fuel, steel rails, ties, car-wheels, bolts, spikes, and lumber, are in some degree cheaper than they were thirteen years ago, but labor seems to have advanced so as to offset, and much more than offset, the decline in price, and economy in use, of material. At any rate, it is more than probable that, taken as a whole, the raw material of transportation is no cheaper than it was. Is there any other industry in this country which has had to face a 27 per cent. decline in its product, without a decline in the price of its raw material?

Here is a reasonably complete explanation of the present position of our railroads. This is why a reduction in the volume of business in the beginning of depression proved so disastrous, and drove 25 per cent. of the mileage of this country into the hands of the courts. While there was plenty of business doing, the trouble was masked, and the insufficiency of the working profit was concealed. Concealment, however, was no longer possible under the strain of the 1893-5 depression. Here, then, is our railroad estate to-day after its trial,—somewhat battered, but within sight of better times. What is to be its development in the next few years?

No one can read the future, but here certain broad lines can be laid down, on which certain conclusions can be based. The future of our railroads depends upon *what they can earn*, and that depends mainly upon *what they get for transportation* and *what it costs to do the business.* A third factor, of course, is *the volume of business done.*

The outlook is not very hopeful for an advance in railroad rates in the near future, as far as the greater part of the country is concerned. In the east, and in the thickly-settled part of the country, rates have ceased to decline as local business has grown up. In New England this local and diversified business has kept the rate per ton-mile steady for some years. The same thing is to be noticed in lesser degree in the middle States (New York, New Jersey, Pennsylvania, etc.), and even in the middle west (Indiana, Illinois, Ohio, Michigan, and Wisconsin) the tendency to decline seems at least partially checked for the same reason. These groups contain one-half, or almost one-half, of the mileage of the entire country. It is even a fact that in the northwest since 1890 the average rate per ton-mile has remained very steady at slightly over one cent. This is a very hopeful sign, indeed, considering the comparatively slight density of business in that section. Nevertheless, it is to be feared that serious havoc has been wrought in rates in the year just ended, the effect of which will be seen in a yet lower average.

While it is true that the growth of population and the consequent growth of local business will steady and even probably advance rates in time, it would not be prudent to reckon on any marked improvement in the near future. Improvement must, of its very nature, be gradual, if it comes at all. It may be questioned whether wholesale pooling would do much more than hold rates steady on an average.

How, therefore, are the railroads to earn increased profit for their owners? Clearly, either *by doing a steadily-increasing business* at the present rate of profit, or *by reducing the cost of doing business.* Let us first consider the latter method.

The cost of production depends upon the cost of raw material and the circumstances of manufacture. The causes which have operated to prevent a fall in the price of the raw material of transportation in the last thirteen years are still in operation. The tendency of the price of semi-skilled labor still seems to be upward, although decline will come some day. There is certainly nothing to warrant the belief that any important lowering of the price of railway labor may be looked for in the near future. On the contrary, increasing business will unquestionably bring demands for advance in wages, and in many cases those demands will have to be granted, at least in part. Let us assume that the price of labor remains unchanged during the next few years. This leaves us but the 40 per cent. of operating expenses representing cost of material in which to hope for a reduction in price.

It may be roughly estimated that train and station supplies account for 12½ per cent., 10 per cent. being fuel. Perhaps fuel may cost less hereafter, but it is cheap now. Rails, ties, lumber, iron, and steel in various forms account for at least 10 per cent. more. Prices for these materials are more likely to advance than to decline. This leaves only about 17½ per cent. to represent miscellaneous items. The prospect for much saving here seems rather doubtful.

Look at it how we will, it seems that the raw material of transportation will not fall much in price in the near future. The railroads are driven back, therefore, on the alternative of concentrating manufacture, so as to cheapen its cost. Here fortunately there are great possibilities. A little has been already done in this direction.

Concentration of manufacture in the transportation industry means the saving of train-mileage,—*i.e.*, economy in units of service performed. It means, therefore, greater efficiency in every train-mile,—more passengers and more tons of freight in every train. In 1883 the number of passengers in each train, on an average, was 45; last year it was 38. In 1883 the average number of tons in each train was 125.86; last year it was 180.23. Calculation shows that, applying the 1883 basis of passenger and freight loads to the business of 1895, there would have been a saving of about 49,000,000 passenger-train-miles, but a loss of 212,250,000 freight-train-miles. Comparing 1895 with 1883, therefore, we see that concentration of manufacture in freight transportation saved 212,150,000 freight-train-miles, while there was a waste of 49,000,000 passenger-miles,—a net saving of about 163,250,000 revenue-train-miles. We may reckon that each revenue-train-mile saved may be valued at about 30 @ 35 cents (this being a rough estimate of the expense items directly dependent upon train-mileage), so that, taking this 163,250,000 at 35 cents each, we have a little more than $57,000,000.

Earlier in this article it was shown that 1895 business done at 1883 rates would have brought in $396,000,000 more than was actually received. Of this amount the railroads have saved only about $57,000,000 by concentration or economy in train-mileage.

The loss in passenger-train-mileage is unavoidable. The railroads have to endure a large waste. That is one reason why passenger business, as a whole, is unprofitable. The saving in freight-train-mileage is, however, considerable, although not nearly enough. It is in this place that the possibilities lie for future profit.

Let us suppose that last year, instead of carrying 180 tons per train, the railroads of the United States had carried an average of 250 tons. This, applied to a ton-mileage of 88,500,000,000 (roughly), would call for a freight-train-mileage of 354,000,000 against an actual freight-train-mileage of 491,500,000. The saving of 137,500,000 of train-miles would have meant an increase in net profit of about $48,000,000, or 15 per cent.

A heavy freight-train-load is a question of two things,—*viz.*, mechanical facilities and good management. It requires, other things being equal, a massive road-bed, easy grades, strong bridges and embankments, capacious rolling stock, and heavy motive power. It also requires extreme care and vigilance on the part of freight agents and yard masters, whose duty it is is to see that trains are well filled before being made up and sent out ; for, if the load is not ready, it is useless to have the means of carrying it.

This is the age of steel bridges, 100-lb. steel rails, and 30-ton freight-cars. Renewals are made with heavier rails and larger equipment. In this respect the roads clearly see their duty and their opportunity. Many, however, do not seem yet to see that, while they cannot get more for a given amount of transportation, they can perform that transportation more economically.

There is no apparent reason why there should not be adopted, all over the country, some system of agreement on freight-train schedules, designed to cut down freight service and carry the traffic in a smaller number of trains. This could very easily be done, if the roads were willing, between important common points. Assuming that competing roads had equal mechanical facilities as to road-bed, bridges, grades, and equipment, no one would lose on such an agreement, and it would be just as easy to allow differentials in schedules as it is now to fix them in rates, where the physical facilities of one road are less than those of the others.

The public does not necessarily suffer by diminution in train-mileage, provided the freight is carried and duly delivered. The difference between sixty hours and seventy-two or eighty-four hours, for example, in the time of a freight train between New York and Chicago, is not much to the shipper, but it is a great deal to the railroad. It might make just the difference between a full load and a load less than full, and it makes a difference in running speed of some miles per hour, involving waste of fuel and wear and tear. The speed question is highly important in itself, as far as freight trains are concerned.

It should not be very difficult to devise a system of freight-train schedules which should cut down train-mileage greatly. A hard-and-fast agreement, such as has been so often attempted on rates, could perhaps be drawn up to limit for each road the number of freight trains to be dispatched per day, due regard being had to the physical efficiency and characteristics of each company. A hundred difficulties in the way of such an agreement could, no doubt, be suggested by practical railroad men, which can be neither anticipated or answered here, but it is submitted that the principle underlying such an agreement is sound, and that enforcement of such agreement, or at least detection of breaches thereof, would be easy and inexpensive. All railroad men know how difficult it is to obtain direct evidence of rate-cutting under existing agreements, and how many ways there are by which rates can be securely and secretly cut.

The railroads have already done a great deal towards bringing their plant up to modern requirements. It is certain, however, that, taking the business as a whole, there has been, and still is, a tremendous waste of energy and money in the shape of train-mileage. Present methods of handling railroad business are relatively as crude and uneconomical as the early process of making pig iron, or spinning cotton. It is in methods that most economies must be looked for henceforth, and the only way to achieve these economies is to lop off unprofitable service.

This matter is in the hands of the railroads themselves, and they can deal with it on the general lines suggested,—*viz.*, by some agreement to limit freight service to actual and well-known requirements between common points and distributing centers. It involves, first, of course, the physical equipping of the roads for the transaction of business in bulk, but, secondly and mainly, the earnest desire of the roads to save money for their owners.

Briefly, then, our argument is this: the railroads cannot safely reckon on an increase in the price of transportation in the near future, nor can they expect a decline in the raw materials from which it is manufactured. Great possibilities for economy, however, exist in the shape of saved train-mileage. (It is fair to say that, with a proper study of the requirements of the public, not only would there be a great saving in train-mileage, but the business could be handled in fewer cars, so that equipment inventories might be smaller.) Also, it is fairly to be assumed that there will be a large increase in the volume of business done in the next few years, so that the amount of railroad net earnings will be increased, whether there is any increase in the ratio of the profit or not.

The growth of railroad business has been very large in the last thirteen years, and surprisingly steady, although 1893 clearly called a halt. The table which follows gives the "freight density" (*i. e.*, the tons carried per mile of road) for thirteen years, and the yearly average during five-year periods beginning 1883–7.

	Freight density.		Do. 5-year average.
1883	421,421		——
1884	395,196		——
1885	402,521		——
1886	421,124		——
1887	449,396	1883–7	417,931
1888	450,134	1884–8	423,674
1889	446,858	1885–9	434,006
1890	501,303	1886–90	453,763
1891	494,333	1887–91	468,405
1892	494,781	1888–92	477,482
1893	522,305	1889–93	491,916
1894	466,551	1890–94	495,254
1895	494,344	1891–95	493,863

We shall probably not be very far wrong, if we estimate the figures for 1896 at about the same as for 1895, which would leave the five-year average for 1892–6 a shade below that for 1891–5. This would show progress delayed very appreciably, as a result of the 1893 panic and all that it entailed. According to precedent, it would mean that considerable recovery is overdue, more especially as this period of stagnation in freight density coincides with a period in which little new mileage was built, relatively speaking, while population has all the time been growing up to the road already built. It does not seem a very rash thing to say that at some time in the next two or three years freight density will surpass its previous record, and probably exceed 550,000 ton-miles per mile of road. Recovery, moreover, will mean recovery under more favorable conditions than ever before, as every year sees improved plant and improved methods in force, so that the railroads will make more net money, relatively, from the increased freight business than they lost by the decrease from 1892. The same remarks apply in a lesser degree to passenger travel, and it is unnecessary to adduce the figures for this department.

We may, then, confidently expect a considerable increase in the amount of railroad profits from an increased volume of business in the next three to five years, independently of rates, wages, or even, to a certain extent, train-mileage, economy, or waste. In this increase of profit lies the opportunity of the railroads to prepare for the future.

If railroad managers in the next two or three years will regard increased profits as a fund on which to draw for money to reduce grades, build heavy locomotives and large freight-cars, lay heavy steel rail, and replace wooden bridges with steel, iron, and stone; and if they will, in addition, agree to try to limit train service to absolute requirements, so as to stop the waste of train-mileage,—they can place the railroads beyond danger of another 1893–5 period, with its list of bankruptcies and defaults, and will be able to face almost any contingency in the future. This, or much of this, however, must be done.

Without making invidious comparisons or drawing unpleasant distinctions, attention may be called to some conspicuous examples of scientific railroading. Great Northern (considering its natural disadvantages) is one,—perhaps the best; Lake Shore is another; Chesapeake & Ohio is another; all these companies are getting relatively more and more profit out of the business done year by year by saving in train-mileage. They can live where others could not, because, for every freight-train-mile run, they get a larger average sum year by year. That is really the whole problem.

It is for this reason that it may be said that the destiny of the railroads is very largely in their own hands. It may be made a bright destiny by rigidly applying to the industry the forethought, science, and economy that is applied in other and simpler industries. The suggestion is hazarded that the problem has been tackled at the wrong end hitherto by the majority of railroad men. They have striven to control the market for their product, but have neglected the question of its production. They have wrangled, quarreled, and fought over rates and tonnage, but they have over-looked the main question,—namely, the amount of work they were doing with that tonnage in wasted train-mileage. Profit depends at least as much upon cost as upon selling price.

Even the most casual observer cannot fail to appreciate the stupendous importance of our great railroad estate, unless, indeed, it has become by acquaintance a commonplace. Such commonplaces, however, lose their stale appearance on investigation. An investment represented by twelve billion dollars of capital is a serious matter. The time is ripe for the managers of this investment to place it once and for all on a solid foundation. If money is needed to do this, it will be furnished in the next two or three years in abundance, by the return of prosperity. If they but grasp the opportunity and use it rightly, the time of fiery trial for the railroads of this country will have passed forever.

NOTE.—The figures relied upon in this article were taken from Poor's Manual, which is the best available record.

THE HOPEFUL OUTLOOK IN THE MECHANICAL WORLD.

A Symposium.

IN the leading article of this Prosperity Number, the general conditions promising a great revival of business are reviewed broadly from the standpoint of the general economic and industrial conditions.

To present the subject in a slightly different light and sum up the situation in another, but no less striking, way, we present below a most valuable symposium of opinions from leading manufacturers,—men who are in actual contact with the trade, watchful of every movement and directly affected by every turn in business affairs. An accurate and most important index of the state and prospects of our industries is thus afforded.

FROM THE WEBSTER CAMP & LANE MACHINE CO., AKRON, O.

The business depression of the last four years has taught many of the progressive manufacturers of this country to look for new markets in which to place their goods, and the increasing demand for American goods and machinery in Mexico, South America, and South Africa is an indication that their efforts are meeting with success. In the mining machinery line—in which we are interested—this has been especially marked, and the foreign demand for American mining machinery has been a wonderful help in tiding us over an otherwise very depressing period of inactivity. This demand for American goods may be increased, if manufacturers will take the pains that German and English makers take to study carefully the wants and peculiarities of the people they wish to deal with, and to see that the goods are packed in a manner to stand the transportation.

The increased competition in all lines of home trade has called forth many new and interesting improvements in processes of manufacture and rapid handling of materials, notable among which have been the increased use of compressed air in shop-handling of machinery and material and the handling of large quantities of coal and ore at all Lake ports, by means of apparatus for dumping railway cars direct into vessels, without the delay and expense of shoveling, etc. The designing and construction of this improved apparatus have done much to keep the various engineering establishments busy. Now that political matters are, for the most part, settled and out of the way,—the uncertainty and lack of-confidence factor being eliminated,

—there is every day more apparent a better feeling, both in commercial and financial circles, and though, happily, there is no prospect of a sudden boom, there is every indication of a gradual improvement in general business. Our customers are giving evidence of this in a substantial way, by placing orders which have been held over until after election. They had the best of reasons for this, as they had no assurance of being able to finance their schemes of improvement until a settled financial policy should be guaranteed.

We are happy to state that we are now assured of a good winter's work for our men, and we have from present inquiries—daily coming in—good prospects for business for 1897.

S. H. Pitkin, General Manager.

From The Berlin Iron Bridge Co., East Berlin, Conn.

In our opinion, nothing stands in the way of a business revival, except a business revival. There is an old saying that nothing succeeds like success, and we are inclined to think that, if people would stop growling and attend to business, business would come.

Our exports are large, the prices of our farm produce have increased, consumption in the past three years has been going along, but production has very materially diminished. The result is that sheer necessity must soon drive us all into the market, and, as soon as labor is employed, business will revive. Our greatest fear is a boom,—that is, that the revival will come quickly, and production will not be ready to meet the consumption, or, in other words, that the demand will be greater than the supply. Chas. M. Jarvis, President.

From Wm. Sellers & Co., Incorporated, Philadelphia.

We had no orders contingent upon McKinley's election, nor did we have any inquiries for work based upon that contingency. We had probably more inquiries before the election than we have had since, in the same time, but the monetary conditions then were widely different from existing ones. Then a general feeling of distrust prevailed, and business paper could scarcely be negotiated at all; now there is an increasing confidence in the future, and no difficulty is found in negotiating legitimate business paper. It is probable that the distrust existing before the election prompted many inquiries, and that the inquirers now feel that they can wait for further evidence of recuperation. Very many of our orders for the last few years involved the use of electric power and electric transmission, and this agency promises increasing proportions in the future. New developments in special industries have furnished considerable orders that must soon be duplicated, and our export trade has been larger than usual,—a condition probably consequent upon the low prices here, due to the general stagnation of manufacturing and transporting industries. At the moment business is dull, but we share in the general opinion that a revival may be looked for in anticipation of wiser legislation under the new administration. WM. SELLERS, President.

FROM THE LIDGERWOOD MANUFACTURING CO.

It is impossible to have a permanent improvement in business while we have to suffer the infliction of the present congress. The reform of the deplorable state of our national finances—the first step to business prosperity—is utterly ignored. Consequently the present spasmodic condition of trade is likely to continue.

JNO. H. LIDGERWOOD, Treasurer.

FROM THE EGAN CO., CINCINNATI.

The business situation at the present time is more perplexing than usual, and we will explain the reason why. After the election of McKinley we had considerable business hanging on that event. Most of this business materialized, and we filled the orders. We had expected, of course, that these orders would continually multiply and business go right along, but to our surprise business has not kept up as it should. The tone of business looks better, and money is easier, and the banks are more willing to discount good paper, and at a lower rate than ever before. It looks to us as if people are waiting for the new administration to come in. We cannot account for it in any other way. Business, we will admit, is a little on the improve, And yet we had expected so great results that it has not quite fulfilled our expectations. We think that when the new administration begins everything will come along to our satisfaction. THE EGAN COMPANY.

FROM THE BROWN & SHARPE MFG. CO., PROVIDENCE.

We have noted in our business a perceptible, though not great, improvement since the election. Only one small order was marked as contingent upon McKinley's election, but our customers seem to regard the election as of probable benefit to them.

During the past year we have been exceptionally busy, owing, we think, chiefly to three causes: an unusual demand for our tools abroad, the orders from the bicycle trade, and the general interest shown in the new designs of our standard machine tools.

Our own desire for the future is that congress should speedily enact some satisfactory legislation in regard to our currency, and should not in any way subordinate that issue to the tariff. If uncertainty in regard to the currency is removed, and general business is not disturbed by a comprehensive change in the tariff, we see no reason why there should not be a large and steady increase in the volume of trade.

BROWN & SHARPE MANUFACTURING CO.

FROM THE HEINE SAFETY BOILER CO., ST. LOUIS.

From our individual standpoint, the business outlook seems very promising. There has been no recent boom in the boiler business, but, as we see it, this is a matter for congratulation rather than regret. A gradual revival of trade, such as we have experienced in the last few weeks, is much more to our liking, and much more promising of continuation. We are feeling very well satisfied, and very hopeful for the future. We anticipate that competition in general will be keener than ever from now on, but we regard that aspect of the situation complacently, for the reason that we think it will involve a closer attention on the part of manufacturers to all possible economies in the operation of their plants. That must mean better business for the manufacturers of fuel-saving boilers and labor-saving machinery in general.

S. D. MERTON, Secretary.

FROM CAHALL SALES DEPARTMENT, PITTSBURG.

For three years general business in our trade has been extremely dull, having shown a steady decline for the full term of three years until March, 1896. The three months following March were very good, and then came an almost total collapse. Almost immediately following the election of McKinley, business picked up very materially, and during the first three weeks after the election it was better than it had been for over a year. Then, for some reason, purchasers throughout the country felt probably that they had overestimated immediate advance in business conditions, and things fell off again, until for the last two weeks both inquiry and actual business have become almost as bad as they were in the past summer. A thorough canvass of the various territories covered by our agents seems to indicate that there will be almost nothing done until after manufacturers have checked up their stock accounts and taken off their trial balances the first part of January, and are able to determine exactly where they stand. The general promise of business for the ensuing year seems to be very good, but it will be impossible to forecast with any degree of accuracy whether this promise will be borne out until about the middle of February. If at that time purchasers do not commence to be active, there is no telling when a healthy reaction will set in. As for our own feelings in the matter, we can only say that we have been very fortunate during the dull times, and, if business is not worse with us in 1897 than it has been in 1896, we shall have no reason to complain.

CAHALL SALES DEPARTMENT.

FROM THE JOSEPH DIXON CRUCIBLE CO., JERSEY CITY.

Business prospects are good,—at least to all who are in any way hopeful or energetic. When we look back over 1896 with an eye single to honest retrospection, we have rather more reason to criticise our own methods than the business situation or the condition of the country. We have slumped, as it were, in those lines where we have been somewhat easy and over-confident, and we have increased largely in those lines where we have put in vigorous and intelligent work. We have also, by extra work and attention, held our own in lines made dull by the stoppage of the many industries in the land.

In looking at the total outcome of 1896, we find we are a little behind 1895,—about 10 per cent. Had our foresight been as good as our hindsight, we believe we could have equalled 1895, if not outdone it. One of Mr. Atkinson's favorite quotations from Emerson is that "man is as lazy as he dares to be," and probably business men are not exceptions.

The outcome of the election made some little difference with us, for we held several orders dependent on the election of McKinley. As we have been personally told of other concerns that held contingent orders, in some cases aggregating a hundred thousand dollars, we have no doubt that McKinley's election was a benefit to the country.

There is no denying the fact that accounts have been hard to collect. We believe our customers have been anxious to pay promptly. We know they have written us manly and business-like letters, but money has been exceedingly hard to get hold of, and notes have been unsatisfactory, because renewals rather than payments were bound to be made.

Our experience is that it has been a season of hard times and many moments of uncertainty, but that nevertheless the spirit of self-help and mutual help has been alive, and is now rapidly making itself felt in the way of better business, which will be still better later.

JOS. DIXON CRUCIBLE CO.

FROM THE LINK BELT ENGINEERING CO., NICETOWN, PHILA.

We are not of those who looked for prosperity in a golden shower on November 4. That restored confidence is not yet translated into higher prices and greatly-increased demand for product should not be cause for disppointment or surprise.

McKinley's election relieved the financial situation. Money is easy of access for all legitimate needs, including discounts.

Orders for repair work and maintenance of manufacturing plants which were held back till the result of the election could be known have since been coming forward to a stimulating extent in machinery lines, but caution, born of the experience of the past three years, still keeps the brake on investments in new enterprises, and they will probably move slowly till a new tariff has been framed and the ability of the new congress to enact the laws essential to continued prosperity has been demonstrated.

In existing conditions we find distinct improvement, and the outlook is for an increasingly rapid development in engineering and mechanical lines. THE LINK-BELT ENGINEERING CO.

FROM FRASER & CHALMERS, CHICAGO.

Our business is active, and we expect continued activity and a prosperous season. We base this opinion upon the simple knowledge that much work is to be done which we, as a firm, are able to execute to the advantage of those requiring it. FRASER & CHALMERS.

FROM H. K. PORTER & CO., PITTSBURG.

We hardly know what reply to make to you. We are having more inquiries at the present time, and greater correspondence, than we ever remember of heretofore, and with every indication of very marked improvement in business in the near future. We ran at approximately half capacity throughout the depression, and are not running nearly full capacity now. We are trying to be conservative on prices, with the hopes of avoiding a boom. Our business includes both home and foreign. People appear to have been postponing purchasing, and quick deliveries are generally asked for. H. K. PORTER & CO.

FROM THE STIRLING CO., CHICAGO.

There has never been a statement submitted to our stock-holders that can compare with the statement that will be submitted to them at the end of this year, in point not only of satisfactory earnings and large volume of business, but also of a most flattering outlook for the the future. Much that is satisfactory in our report can be attributed directly to the favorable financial and political developments within the past sixty days. As a direct result of McKinley's election contracts that had been closed conditionally for large amounts became immediately effective, and a great number of concerns that had been deferring needed improvements, either because of the disinclination to spend money, or because of inability to market their securities, have opened negotiations for extensive additions to their plants.

The outlook, while it is not without a fleck of cloud here and there, is encouraging, and certainly seems to offer the promise of eminently satisfactory returns to all manufacturing concerns that proceed with vigor, and at the same time with caution.

EDW. R. STETTINIUS, Treasurer.

FROM THE EDWARD P. ALLIS COMPANY, MILWAUKEE.

During the past month we have received about the customary number of orders. We notice no special change in the volume of business since election. Our works are fairly well occupied, and we were for tunate enough to have a fair amount of business on hand most of the time during the past two years. THE EDWARD P. ALLIS COMPANY.

FROM THE PRATT & WHITNEY CO., HARTFORD.

Every one knows how strained the situation was prior to November 4. Since that date the aspect of affairs has completely changed, and where buyers of our goods did not wish to even discuss the possibility of a purchase they are now inquiring from every direction.

A few orders were placed with us contingent upon the election of Mr. McKinley. We think that the majority of our customers now regard the present conditions as very satisfactory, and look for a large business during 1897, and a still larger one in 1898.

Neither they or we expect or wish for what is commonly known as a "boom." The disappointment at the slow revival of business which we hear now and then expressed appears to emanate only from over-sanguine individuals who expected the country could recover from its very serious condition in the course of twenty-four hours. One satisfactory point we have noticed is the greater promptitude in paying accounts and settling up old standing matters. This is undoubtedly caused by the greater facilities extended by bankers all over the country to their customers. The question is not now how much accommodation will the bankers give their customers, but how much money can the customer use. Of course, in saying this, we refer only to firms of the highest standing.

The extended increase in the use of bicycles has had a material bearing on our business, as we have been called upon to equip factories all over this country for this purpose, and have also shipped similar goods to various European points. It seems as though the bicycle craze was just getting into full swing in Europe, as factories are springing up everywhere.

Our export trade is steadily increasing, and there is hardly a country in the world from which we do not receive inquiries for some goods of our manufacture. J. C. STIRLING, Treasurer.

FROM THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VT.

We would say that the condition of business, as we have found it, is best reflected in our running time, which during the first six months of 1896 was sixty hours a week, and then fell to thirty-two hours a week, the latter rate continuing until one week after election. Since then we have been running forty-eight hours a week.

Our orders seem to go up and down with the stock market to an extent that would indicate that convalescent business is extremely sensitive on its bump of confidence, which was made sore by the recent tumble. JAMES HARTNESS, Manager.

FROM J. A. FAY & CO., CINCINNATI.

We are pleased to find the business outlook such as to fill us with a reasonable hope that in the very near future we shall begin to reap the benefit of an increased volume of business. Unquestionably we have with us the ear-marks of an early resumption of at least normal times. We find collections easier, and in some localities there has already been improvement in orders. We are happy at the outlook.

J. A. FAY & CO.

FROM THE A. S. CAMERON STEAM PUMP WORKS, N. Y.

We have not experienced any marked improvement in business since election, but, from what information we have been able to obtain, we have every reason to anticipate a decided change for the better this coming spring. THE A. S. CAMERON STEAM PUMP WORKS.

FROM THE DEANE STEAM PUMP CO., HOLYOKE, MASS.

The pump manufacturers probably come in contact with a greater variety of enterprises than any one industry. Mining, manufacturing, building, railroads, electricity, and shipping all involve the use of hydraulic machinery, and we have to meet these interests daily.

There has been no marked increase in orders for machinery since the national election, and very little increase in inquiries. There is, as before, a large volume of business waiting for an uncertain future.

During the past three years every branch of business has suffered. Some have been much more affected than others, and a few have been entirely crippled. Some men, with ample funds at their command and with undaunted faith in the permanence of our institutions, have taken advantage of the low prices of the period to make improvements in their plant and equipment.

On the other hand, the majority of business interests appear to be still waiting for the return of prosperity before making purchases or instituting contemplated improvements.

The laboring classes are users and producers of all products. They have been taught economy by the hard experiences of the past few years, and must continue to practise it until labor is much more in demand than at present. Our observation leads us to the opinion that there will be a gradual and increasing demand for labor if there is no untoward legislation, such as a revision of the tariff to too greatly increased duties or beyond a reasonable basis for necessary revenue. We believe that, as each industry in its turn feels the improvement, it will help all allied interests. LEWIS E. BELLOWS, General Manager.

REVIEW OF THE ENGINEERING PRESS

THE AMERICAN PRESS

Historical Sketch of the Bessemer Process.

AN account of the origin and development of the bessemer process, and a defence against the statement lately put forward in some quarters that the invention was anticipated by W. Kelly, an American, was presented in a paper by Sir Henry Bessemer at the December meeting of the American Society of Mechanical Engineers. It seems clear from this account that, although Kelly secured a patent in November, 1857, the process of making bessemer steel could not have been carried out in such an apparatus, which would project and discharge vertically a large proportion of its contents during the explosive eruption of slags which always occurs towards the end and is an inseparable concomitant of a successful conversion. We think no unbiassed person can read this paper without arriving at this conclusion. A very convincing undertone of candor pervades the paper, adding force to its statements.

Sir Henry Bessemer commenced his experiments in 1855. They were first directed to toughening cast iron by the fusion therein of malleable scrap iron. Previous experimenters had sought to do the same thing, but their efforts had resulted in a white cast iron, so much contaminated with sulphur that the method had largely failed to reach the object sought. Bessemer used a reverbatory furnace, in which the pig-iron was fused, and into this bath he put pieces of Swedish or other charcoal iron, which was thus fused out of contact with the fuel. This avoided the absorption of sulphur. His patent for this process was taken out in January, 1855. Of course there followed alterations and modifications. The result was a metal which, when annealed, had a fine grain and great strength, and which, when polished, looked like steel. Of this metal Mr. Bessemer made a small model gun, and took it to France, where he exhibited it to the emperor, and obtained permission to establish a cannon factory at Ruelle, near Angoulême.

Sir Henry returned to London and resumed his researches, during which he was diverted from the Ruelle project by results obtained in his experiments. Two months later he took out a patent for forcing air into the closed ash-pits of furnaces for making cast steel, as the outcome of his attempts to increase temperature by the use of a larger furnace and a forced draft.

At this point his open-hearth experiments were abandoned. While he makes no claim to a prior invention of the Martin-Siemens process patented in 1865 by Emile Martin, he thinks he certainly approached within a measurable distance of it. Bessemer was diverted from this line of experiment by a phenomenon which he observed in his open-hearth experiments. Some pieces of pig iron in one side of the bath remaining unmelted, he turned on a little more air through the fire bridge with the intention of increasing the combustion; but at the end of half an hour they still remained unfused. He then took a bar of iron to push the unmelted pieces into the bath, when he found that they were mere shells of decarburized iron. Here was the indication that air alone could decarburize gray pig-iron and convert it into malleable iron without any further manipulation. By following up this clue skilfully the great invention was reached.

Emphasis is placed upon rapidity of action as essential to success; in this way only can the necessary high temperature be attained,—a temperature considerably above the point at which malleable iron fuses, and which prevents the cooler deoxidizing metal from chilling it, or the formation of skulls in the casting ladle while the ingots are being poured. A knowledge of these conditions and requisites, it is claimed, does not appear in the specification and drawing of the Kelly patent of 1857.

Mr. Bessemer also alludes in his paper to his anticipation of Mr. Mushet's use of German pig-iron for recarburation of the converted metal after the blow, this anticipation having been described in his patent taken out October 17, 1855. In his patent of May 31, 1856, he claims to have anticipated also Sir Joseph Whitworth's invention for casting steel under great pressure. From this point on the advances were confined to details, until finally the semi-rotary converter crowned a long list of improvements.

All this has been often retold in various forms and places. The principal interest of Sir Henry Bessemer's paper, apart from the inherent interest in any story of a great invention, lies in the fact of his having been elected an honorary member of the society before which the paper was presented, and his high appreciation of this honor, as expressed in his opening remarks.

Newer Tendencies in Street-Paving.

An editorial upon "Narrower Pavements for City Streets" is introduced, by *The Engineering Record*, with some excellent comment upon a noteworthy change in the policy of municipal engineers, observable in many recent cases. The change is properly regarded as a distinct advance. "The rising standard of municipal engineering in American cities," says the *Record*, "is shown in the increasing space given in the annual reports of city engineers to discussions of improved methods of practice and suggestions for further improvements. The old-style report, confined to numerical tables of work done, is becoming a rarity, and suggestions as to desirable changes in present working methods are to be found in the reports from nearly all of our cities."

This is as it should be. The executive officers of towns and cities and the members of executive boards are rarely men of technical education, or competent (even when desirous of doing so) to originate improvements in places or methods of work.

The engineer with a proper appreciation of his relations to the employing corporate board and his duties to the public will have no hesitation in going beyond the letter of his instructions in advice and recommendation, and no fear that critics worthy of respect will consider such action *ultra vires*.

The *Record's* comment is called out by the "particular instance" of "the subject of street paving, whose economics are now being very carefully studied. One result of this is a tendency in many places to reduce the width of the paved portion of residential city streets, necessitating an increase of the sidewalk width or in having a wider strip of grass between the sidewalk and gutter. In the days of cobblestone pavements, now rapidly disappearing, it was cheaper to have narrow sidewalks and broad roadways, but, with the introduction of asphalt and brick as paving materials, and the recognition of the necessity of having a solid, though expensive, foundation under all pavements, the economy of having narrower roadways soon became apparent, and the wide, unkept street of village days has given way to the narrow, well-kept city street. It is generally admitted that a wide street is handsome, but that it is just as handsome with a paved carriageway of moderate width and a broad stretch of grass between the sidewalk and curb does no seem to have been as quickly realized. There is many a wide street in our smaller cities and towns that has no pavement or a poor pavement, because the expense of paving the present width of roadway is too great."

Direct examples of the effects of this tendency are cited in the cities of Toronto and Albany, where a reduction of five or six feet in paved width of residential streets has "improved the appearance of the streets, and given satisfaction to the residents." Further economical arguments are advanced in the reduced expense and labor of cleaning and sprinkling the narrower pavements, and in the convenience afforded by the idle strip as a dumping-place for snow from sidewalks, gutters, and roadways, in all cases where no regular provision is made for the removal of the snowfall.

There is one influence bearing upon the relative width of roadway and sidewalk which is not mentioned in the discussion in the *Record*, but which must undoubtedly be dealt with,—the bicycle. Overdone at present, perhaps, it is nevertheless beyond question an enduring development, and the transfer of so large a volume of street traffic from the sidewalk to the roadway will have to be allowed for in some adequate way. Possibly the solution may be found in making three divisions of the traffic, and the side-strips, specially and perhaps lightly paved, may accommodate the lighter vehicles.

An exchange recently announced that Gen. Collis was considering, or had adopted, a plan for laying a narrow asphalt strip next to the curb on granite-paved streets in New York, so as to relieve the congestion of bicycle movement on the fully-asphalted thoroughfares. The craze for wheeling has excited so much merited ridicule that it is hard to regard it seriously; but it has a sober side and substantial claims, which the modern city engineer must recognize and reckon with.

The Cyanid-Process Patents in the Transvaal.

THE decision of the high court of the South African Republic, pronouncing the MacArthur-Forrest cyanid patents invalid, is one of the most talked-about recent events in mining and financial circles.

An able editorial in *The Engineering and Mining Journal* (Nov. 14) discusses the obvious and probable future effects of this decision upon the gold-mining industry in the Transvaal, and elsewhere. It was in the Transvaal that the cyanid process first came into use. Nevertheless, as pointed out by our contemporary, it is a fact that, in connection with the long and vigorously-contested litigation to which the patents have been subjected, American expert testimony has been largely relied upon in the contest, this testimony having been taken in New York by a special commissioner from the Transvaal. The earnings of the mines in the South African Republic were largely increased at small cost by leaching tailings with cyanid solution. As a consequence, the process was adopted elsewhere. At first royalties were paid by the Transvaal mine-owners without demur, but increasing resistance to payment of royalties at last led to the suit which has terminated thus unfavorably to the African Gold Recovery Company owning the patents for that country. The editorial referred to reviews briefly the situation in other countries. In England the validity of the patents has been adversely passed upon, but the case has not been carried up to the highest court. The patents in Australia have been amended and their scope reduced. They are owned by The Australian Gold Recovery Company. It is said that the use of the process on an extensive scale has been commenced in the gold mines of New Zealand. Little has been done with the process in Mexico, though the patents for that country were sold to a company for a large sum. The patents in this country are owned by the Gold and Silver Extraction Company of Denver, and the process is said to be in use in several places. A suit brought by the company to recover royalties from the Mercur Gold Mining Company, in Utah, was compromised on terms so favorable to the defendants as to indicate a want of confidence on the part of the Gold and Silver Extraction Company that they could obtain a decision favorable to their claims. Thus the patents have never been brought to a judicial test in the United States.

Our contemporary makes some remarks relative to misleading comments upon the decision of the Transvaal court, and designed to correct misapprehensions as to the importance this process holds among means for getting gold. It says: "The decision just given, though final so far as it goes, applies to the South African Republic alone. It is not binding upon the courts of any other country, though it might incidentally have considerable effect upon their opinions. Even if of general effect, the result of the decision would not be so great as some of our contemporaries seem to think. Potassium cyanid is not by any means a universal panacea for refractory gold ores. In many places it has failed to give satisfactory results, and has nowhere attained so close an extraction as the chlorination process, for instance. In some cases, as in the Transvaal, it has been a very efficient help, but its range of usefulness is limited to certain classes of ores. It may be doubted whether the gold production of the world would have been very much less than it is to-day, had its peculiar solvent properties remained unknown, since the use of chlorine, bromine, and other chemicals would have taken its place. To say, as one writer did recently, that the use of cyanid opened vast possibilities for increased production of gold all over the world is simply nonsense. . . . After all, the chief effect of the decision will be to cut off a large part of the revenue of the African Gold Recovery Company, and therefore of its chief stockholder, The Cassel Gold-Extracting Company, and, by relieving the Witwatersrand mining companies from the payment of royalties, to give them some aid in the reduction of expenses, which many of them sorely need to make."

Power Absorbed in Driving Shafts and Belts.

THE fact has long been known that much power is wasted needlessly in driving shafts, belts, and counter-shafts, in the average shops and factories throughout the country. There are, however, notable exceptions, where simplicity in arrangement, perfect alignment, and thorough lubrication appear to have reduced loss of power to a minimum. The magnitude of this loss has been urged from time to time upon public attention, but experiments to determine it, described by Mr. C. H. Benjamin in a paper presented by him at the December meeting of the American Society of Mechanical Engineers, are of value,—at least as cumulative evidence. No great degree of accuracy is claimed for the results obtained, but Mr. Benjamiu thinks them reasonably close to the truth. The method employed was to take indicator cards at about hourly intervals, while a factory was in full operation, and, during the noon hour or after working hours at night, to take cards from the engine when driving line and counter-shafting only. "Averages of these two sets of cards are assumed to show respectively the total horse-power and the friction horse-power in that establishment." The method could easily introduce grave inaccuracies in estimating the loss of power due to friction of line-shafting, counter-shafting, and belts, as the sum of these and friction losses of the engine would be represented by the differences of power indicated by the average total horse-power cards and the average friction horse-power cards. Any one familiar with the running of a steam engine can judge how wide a variation in the friction of an engine can be made through adjustments of bearings, stuffing-boxes, piston rings, gibs, and slides. The separation of the frictional loss, determined by cards so taken, into parts indicating that due to the engine and that due to the system of shafts, counter-shafts, and belts would be a work of difficulty. What would thus be shown would also be different from the friction of the shafts, etc., under full working load, thus adding to the difficulty of apportioning the friction losses to the different parts of the system of transmission. However, there is no doubt that some general indication of the needless losses caused by friction would be gained by such experiments. Tables of data presented show results that, in some instances, almost stagger belief. Taking the range of sixteen establishments, they show that from fifty-five to sixty-five per cent. of the power of the engine is absorbed by itself and the transmitting mechanism before the useful work is reached. Much of this is attributable to imperfect lubrication, but probably more loss results from complicated systems of shafting; and Mr. Benjamin suggests the wisdom of considering electrical transmission in cases where such complications would be otherwise necessary. The following suggestions for reducing the friction are made:

"Use pulleys of large diameter on counters and narrow fast-running belts. Use nothing but the best oil and plenty of it, catching all drip, and either purifying it or using it for some other purpose. Have all the shafting and counters oiled regularly, and do not depend too much on automatic oiling. Inspect line shafts from time to time, and see that they are in line and can be turned easily."

American Street-Railway Property.

VERY few people outside of railway circles realize the magnitude of the street-railway industry at the present day. The prosperity of street-railways, as contrasted with other railway enterprises, is little thought of by the general public. The fact is that some of the very best investments are found in street-railway property. This fact cannot fail to be impressed upon the minds of even casual readers of "The Great Street-Railway Properties of America" in the *Street Railway Journal* for October, which contains a tabulated statement of the financial characteristics of twenty-nine surface and elevated roads, whose gross annual earnings equal, or exceed, one million dollars. While much of the railroad property in the United States has been placed in the hands of receivers, it is a notable fact that only two of the twenty-nine street-railway systems thus tabulated have ever been in the hands of a receiver or experienced any serious financial embarrassments. The strength and the weakness of each of the great properties named are also discussed in the article. Thus the Manhattan railway system, of New York, which is second in value and importance only to that of the Union Traction Company of Philadelphia, is shown to be earning $269,600 per mile of road, or $96,700 per mile of track. The Union Traction Company, with more than double the capital stock of the Manhattan Railway Company, earned in the year ending June 30, 1896, the sum of $10,210,026, while the earnings of the Manhattan for the year ending December 31, 1895, were $9,731,213, or only $478,813 less. The Union Traction Company owns four hundred and thirty miles of track, whereas the Manhattan Railway Company owns only a fraction over one hundred miles. The earnings of the latter per mile are, therefore, more than four times the earnings per mile of the Union Traction Company. As compared with the earnings per mile of the New York Central and Hudson River Railroad, the earnings of the Manhattan Railway per mile are more than fourteen times as large. The road is operated for sixty per cent. of its gross receipts, nineteen and one-tenth per cent. of these receipts being required to meet interest on the funded debt. It is thus shown that, while the possibility of reductions of dividends is admitted, the affairs of the company are extremely prosperous. The Metropolitan Railway of New York presents an example of a railway system with seemingly great possibilities. "It operates one hundred and eighty-nine miles of track, improved motive powers being used on less than twenty per cent. of the mileage. Its lines are a network covering the entire lower end of the city, while it controls or holds the key to eight out of a possible eleven north and south avenues running lengthwise of the island. Its cable and electric lines, which form seventeen per cent. of its entire mileage, are earning thirty-nine per cent. of the gross revenue." Notwithstanding this fact, its earnings per mile are exceeded by only three other roads, one of which is the Third Avenue Railroad of New York, a surface cable road of phenomenal earning power with comparatively small mileage. Its earning power is placed at $190,700 per mile; its cost of operation is about fifty-five per cent. of its gross receipts; its interest charges are only nine and four-tenths per cent. of its gross receipts; and its dividends for the last two years have been eight per cent.

These are samples of the kind of information given in the compilation under notice, which will be very useful as a guide to investors, and will afford to the general reader a means of comparing the magnitude of the street-railway industry with other great American industrial interests.

Corrosion of Iron and Steel Used for Building Purposes.

SIGNIFICANT facts were presented in a paper by Mr. M. P. Wood at the December meeting of the American Society of Mechanical Engineers. The paper is the fourth presented upon the topic of rustless coatings for iron and steel. The author states that it was intended that the paper should be devoted to the subject of oils and other vehicles used in paint processes. But, since the third paper was presented, "so many examples of the vagaries of corrosion of metallic bodies have presented themselves . . . that, in lieu of the vehicle subject," the author presents "a case of corrosion of so remarkable a character, and one in which the record is so positive in its details, that it is removed from the category of speculation as to its cause." A case reported in *Engineering* (July 31), wherein the engines and boilers of the steamer Glenarm were almost destroyed by corrosion during a six-days' submergence after striking a rock in the Sound of Mull, is cited as proving the fact that oiled and painted surfaces may be made very resistant to corroding agents. While the parts not oiled and painted were almost entirely corroded, so that they might easily be cut with a pocket-knife, those coated with oil were scarcely affected. Mr. Wood casts doubts upon the durability of the tall metallic structures that have been erected. He alleges that "it is an indispensable condition in applying paint for the protection of metallic surfaces—disregarded in many of these buildings—that the surface must first be prepared by cleaning it to receive the paint;" and that " the manner and time of applying the coating are strong factors towards getting a favorable result." In previous papers cases of destructive corrosion where this action is very apparent were cited. These include so important structures as the Niagara Falls and Brooklyn suspension bridges, the Victoria tubular bridge across the St. Lawrence river at Montreal, the Firth of Forth cantilever bridge, and elevated railway and viaduct constructions in New York. Of these the author now remarks that there was "evidently a wrong conception from the beginning of what was necessary for the protection from corrosion of these costly structures, so that their life could be measured by the lapse of centuries instead of decades."

With reference to the new suspension bridge between New York and Brooklyn, the North river bridge, and the East river cantilever bridge,—"three of the most costly and important metallic structures" in the world,—the author implies the hope that, in view of more advanced knowledge upon the means of producing rustless coatings, these structures will be better protected than those previously named. He condemns the use of linseed oil free from any pigment, and also the use of oxid of iron in any form for the protection of metallic surfaces. Great stress is laid upon the preparation of surfaces before applying the paint. A poor paint upon a properly-prepared surface may be even more effective than a good paint upon a surface improperly prepared.

Passenger Elevators.

A RECENT accident to one of the elevators in the twenty-two story building of the American Tract Society in New York city was made the occasion of a sensible and timely editorial in *Engineering News* (Nov. 26). As the passenger elevator has made the tall-building system practicable as a business enterprise, so upon its reliability and safety the perpetuation of this system of construction must depend While absolute immunity from accident can hardly be expected from any human contrivance, when the liability of accident becomes reduced to a possibility sufficiently remote, it may be disregarded, like a negligible quantity in mathematics; and the infrequency of accidents in passenger elevators showed that this means of conveyance, a few years ago, was nearly or quite brought up to this standard of safety. But with increase of height in buildings has come the practical necessity for increased rapidity of motion, and this may easily introduce a factor of increased hazard, unless most careful attention is bestowed upon mechanical construction and design. The point made by our contemporary is that it would require but a very few such accidents as that in the Tract Society building to cause such a loss of confidence on the part of tenants as would react most unfavorably upon the rentals of offices in tall buildings; and that, therefore, it is a matter of vital importance to all in any way interested in such buildings to see that accidents of the kind named (or of any other dangerous kind) to passenger elevators should be rendered practically impossible. Reliance upon the inspection of any municipal or State bureau is shown to be unwise from a comparison of the reports of the New York building department for the years 1895 and 1896, which show that either the inspection for 1896 was much too severe, or that of 1895 was much too lax. In 1896 nearly twice as many inspections were made in the first nine months by this department as were made in the first nine months of 1895, and 856 elevators were reported defective, as against 62 so reported in 1895. Does any one believe that nearly fourteen times as many defects existed in 1896 in less than double the number of inspected elevators? If this were possible, it would of itself justify general alarm among the tenants of high buildings. In 1896, 912 elevators were made safe on notice from the department, while in 1895 only 44 were made safe on such notice, and it is pertinently asked: "what guarantee have we that," as regards thoroughness of inspection, "we may not in a year or two return to the conditions of 1895?" It certainly seems that elevators can be designed to run with sufficient safety at a speed of from six to seven hundred feet per minute,—a speed thought necessary in buildings of fourteen stories and upward; but, with the highest skill and most perfect construction, the necessity for strict vigilance cannot be obviated. Without constant vigilant care and inspection all safety appliances, are liable to fail when it is most essential that they should act promptly and efficiently.

A Study in Water Purification.

An account of one of the most interesting and instructive experiences in water purification and filtration we have recently seen recorded is contained in an article entitled "Removal of Iron from Water from a Filter Gallery at Reading, Mass.," the text and illustrations of which occupy about nine columns of *Engineering News* (Nov. 26). It affords a view of a struggle with extraordinary conditions and a final triumph over all difficulties, supplying a clear, sparkling, and good water, where formerly only a fetid, discolored fluid, unfitted for domestic purposes, was obtainable. In some cases this water was as dark as beer, and in nearly all cases its odor was disgusting. A very curious phenomenon was observed; water delivered in two adjacent houses would often differ widely in quality on the same day; and even in one and the same house a notable difference in quality of water drawn simultaneously from different pipes was apparent. The cause of this peculiarity was finally traced to differences in the material of the pipes themselves. The water was contaminated with sulphate of iron, and reacted differently upon the pipes, according to peculiarities in the metal of which they were made.

In April, May, and June, the water was colorless. After the first of July it became colored, ranging from 0.02 in December to 0.40 in August (average 0.13), and falling to 0.04 in November, in which month the heaviest sediment deposited. Not only were the variations such as above indicated during a single year, but in 1892 the average of color rose to 0.44, being zero in January and 0.80 in December. In 1893 the color average was 0.64. The odor is variously described as having been "faintly moldy," "unpleasant," "disagreeable." A heavy, rusty deposit, intermingled with partly nitrified organic matter, took place after standing. The water contained scarcely any oxygen, but was charged with offensive gases. Experiments extending over long periods, and made by experts, at last led up to a system of mechanical filtration which has proved effective in rendering exceptionally good a water which before treatment was exceptionally bad. The system which has effected this notable change comprises the addition of lime (made from marble in northern Vermont, found better than common commercial lime), aeration, coagulation with alum, and mechanical filtration; but this statement by no means gives an adequate idea of details introduced to meet special difficulties, an example of which is the fact that, owing to the changeable character of the water, an hourly test for the quantity of iron in the inflow is made, and both before and after aeration, as well as after coagulation, a test for iron and also for alkalinity is made. There have been few instances of greater difficulties more skilfully met by science in the matter of water-supply, and the results show possibilities in the treatment of water that must be highly reassuring to municipalities now grappling with, perhaps, equally difficult problems. The tables of analyses of filtered and unfiltered water accompanying this article show that the addition of lime increases the carbonate of lime in the water, in parts per 100,000, from 3.80 parts of lime in the unfiltered to 6.40 parts in the filtered water. Costs of details of plant are given, and the article is, as a whole, one of the best in the current literature of water-supply.

The Maxim Steel.

THE statements recently put forth in the *Philadelphia Record* regarding a new steel discovered by Mr. Samuel Maxim, a brother of Mr. Hiram Maxim, the well-known inventor, are such, we should think, as no creditable newspaper would venture to print without some substantial foundation for them. The average daily newspaper often is misled into erroneous statements about mechanical and scientific matters, but it is not apt to quote eminent authorities as endorsing the statements of others, unless it has good reason to believe that denials will not be forthcoming. We certainly hope that all that is told of Mr. Maxim's discovery will prove to be fact; but we shall remain in a wholesome state of skepticism until the stories are fully substantiated. So much has been done in the improvement of steel, and so many announcements of wonderful discoveries by which steel was claimed to gain remarkable properties have come to naught, that even Mr. Maxim would pardon engineers who refused to credit another alleged discovery of the same kind without other evidence than the assertion of a daily newspaper. Meanwhile, it will interest people to know what it is now said that Mr. Maxim has discovered.

Mr. Maxim has an experimental laboratory at Wayne, Maine, and there, it is claimed, he has discovered a process of making steel which he believes identical with the steel of ancient India, alleged to have been far superior in quality to any steel known to modern mechanicians and metallurgists, until its rediscovery at Wayne. It is further alleged that the brothers Maxim are now fitting up a laboratory and manufactory in London for the commercial production of this remarkable metal. For armor-plating it is claimed that the new steel can be made to resist any projectile now known, even when thrown by the highest explosives, and when the plating is thinner and lighter than that now employed.

But that which—if it prove to be well-founded—will be of most interest to readers of this department is the asserted tool-making value of the new steel. "Chisels and drills, made from common iron into steel, through the process discovered by Mr. Maxim, have been submitted to the most celebrated steel-makers of London, who have pronounced them the most wonderful product of modern times. Several drills made from Maxim steel and used by Vickers, Sons & Co., London, steel and iron workers, have been found to withstand marvelous tests. With these tools the best steel known has been drilled, and the drills have not been marred in the least. A small knife blade, made from the Maxim steel, possesses the wonderful power of cutting glass with as much ease as if the glass were chalk."

Now, if all this be true, the world will not long wait for its verification. We repeat the hope that it may be true. It would be a great addition to mechanical resources to be able to tool ordinary tempered steel or case-hardened surfaces. We once saw a New York mechanic drill a hole through the flat point of a hardened and tempered steel V-point drill. At the time we refused to believe that he did it, as he claimed, with steel of an extraordinary quality, of which he possessed the secret, particularly as we were not permitted to handle the drill with which the feat was performed. We always believed that the tool was armed with diamond dust or bort. Certain it is that results promised at the time never materialized. And other putative discoveries of steel superior to anything ever before known,—have they not occurred about one in a decade, and are they now anywhere visible?

The Siberian Railroad.

OUR esteemed contemporary, *The Railroad Gazette* (Oct. 23), gives a useful list of articles relating to the Siberian Railroad which have appeared from time to time in its columns. To any one who desires to collect the literature of the subject, these articles would be simply indispensable, as from them nearly or quite the entire history of this great enterprise could be compiled. The article containing this list gives a consecutive narrative of some of the more important particulars in the history of the road, which is the latest contribution to the literature of the subject. We shall in this review note only a few points. For a complete summary the article itself should be consulted.

The road was proposed by English capitalists in 1858, and was to connect Moscow with the Straits of Tartary. The proposition was rejected for political reasons. In 1891 it was decided that the road should be built by Russian engineers with Russian capital, and on February 21 of that year Nicolas II inaugurated the enterprise with appropriate ceremonies at Vladivastok.

The road, when completed, will be of a length approached by only the great American transcontinental lines, its total extent being 4,776 miles, "not including the principal branches the main line."

A great many details, which we are compelled to pass with this simple mention, are presented in the article reviewed. Among these is a table of the costs of the various items of construction for each of the seven sections, which will be studied with interest by practical railroad builders and civil engineers. The average total cost per mile, as per this table, is $38,396, estimating the value of the silver rouble at 75 cents in American currency.

The Steel Arch Roof of the Chicago Coliseum.

THE subject of roofs has recently occupied an unusually large amount of space in current architectural and engineering literature. In the American papers the most notable article relating to the subject is an illustrated description of the steel arch roof of the Chicago Coliseum, in *Engineering News* (Nov. 22). The details of this roof, presented in a form sufficiently complete to indicate the principal and most interesting features, are illustrated on a two-page folding inset. Perspective views of exterior and interior are also presented in connection with four or five columns of text.

The building for which this extensive and interesting roof was designed is 675 feet 2 inches long, exclusive of its vestibule, and 300 feet wide in its outside dimensions. Our contemporary compares the span of this roof with that of six other notable roof spans, as follows: The roof of the Manufactures building at the Columbian Exposition, with a span of 368 feet; that of Machinery Hall, Paris Exposition, 1889, 364 feet; that of the Pennsylvania Railroad station at Philadelphia, 300 feet 8 inches; that of the Pennsylvania R. R. station, Jersey City, 252 feet 8 inches; that of the Philadelphia & Reading Railroad, Philadelphia, 259 feet; and that of the Midland Railway station, London, 240 feet.

A more popular idea of the size of the Chicago Coliseum is afforded by a comparison of its holding capacity with that of other large buildings used for popular assemblies. This shows that only one building—St. Peter's at Rome—can accommodate more people. St. Peter's holds 54,000 people, while the Coliseum accommodates 50,000.

Obviously such a notice as this cannot go into the details presented in the illustrations. It may be useful, however, to mention the loads for which the metal work was calculated: Dead load per square foot, 25 pounds; live load, vertical snow and wind, 20 pounds; live load, horizontal wind, 30 pounds. For purlins, dead load, 12 pounds; live load, vertical, 30 pounds. For gallery and roof girders, dead and live loads, 80 pounds. The maximum allowable strains for main trusses were 16,500 pounds per square inch; purlins, 14,500 pounds; and, for gallery and roof girders, 15,000 pounds.

Higher Steam Pressures to be Striven For.

CONTRARY to the views expressed on page 341, November number of this magazine, Mr. J. R. Fothergill, in a paper read before the Northeast Coast Institution of Engineers and Shipbuilders, and printed in the *Journal of the American Society of Naval Engineers* for November, believes that engineers will not be deterred from attempts to reach higher steam pressures on account of inherent difficulties. Some of these difficulties were enumerated in our review on the page named. In support of this opinion he recalls the facts that improvements upon steam engines, particularly marine steam engines, have always been adopted slowly, and only after prolonged trial have proved their value and practicability, and that such a stage of progress has been reached that further increase of fuel economy is hardly conceivable without further increase in working steam pressures. He seems to imply that without such increase a general advance from triple to quadruple expansion engines for marine propulsion is not likely to be made. Then he asks whether we are to stop at one hundred and eighty pounds or at two hundred pounds per square inch, and whether engineers will not push on to a further limit? He himself takes the affirmative side of the question. He argues that at each onward step in the march of progress, from the simple expanding engine up to the triple expansion, each advance being attended with an increase of working pressure, the proposed increase has been met with the same objections based upon difficulties arising from increased temperature. Because these have not hitherto availed to check increase in working pressure, he argues that they will not prevail against further progress in the same direction. Perhaps this may prove correct, and quadruple-expansion engines may become the rule on sea-going vessels, instead of remaining the exception. All the same the objections made to increased pressure were, and still are, valid. They have been met by the addition of increased mechanical resources to the previous stock. But this cannot go on forever. There is a theoretical limit to the gain in power obtainable by a unit consumption of fuel, even were we able to surmount all mechanical difficulties. The trouble is that there is no theoretical limit to the cost of surmounting difficulties; and, when this cost counterbalances the gain in fuel economy, the practical limit of advance has been reached. We repeat that, in our opinion, the limit has been very nearly approached.

THE BRITISH PRESS

A Recently-Developed Industry.

THE Philosophical Society of Glasgow is an association which, in its aims and methods, somewhat resembles the Franklin Institute in Philadelphia. Its transactions for the past year contain, among much other valuable matter, a paper read before the society by A. Humboldt Sexton, professor of metallurgy in Glasgow and West of Scotland Technical College, in which he deals with what the author styles "practically a new industry." The title of Professor Sexton's paper is "The By-Products of the Blast Furnace," and it describes the recovery of these products, in which Messrs. Baird & Co., at their Gartsherrie works in Scotland, made the beginning. Their plant for this purpose was designed by Messrs. Alexander and McCash, who are, therefore, regarded as the pioneers in this industry. It appears, however, that the credit ought to be divided between this engineering firm and the owners of the Gartsherrie works. Of Professor Sexton's paper we will endeavor to make such a summary as will afford the general reader some idea of the rise, extent, and importance of the new industry. The owners of the Gartsherrie works have the credit of being among the most progressive in Scotland. They were the first to adopt the Neilson hot blast in 1830, or thereabouts,—an innovation of inestimable value to Scotch ironmasters,—and their experiment in 1880 has had results scarcely less important. The courage and confidence with which they attacked the problem is worthy of all admiration. The experiment, from its nature, did not admit of cheaply-constructed tentative apparatus, but entailed the erection of a large and costly plant, in many points strikingly analogous to gas works. Professor Sexton states the problem as follows:

"What had to be done was to separate the tar, amounting to about twenty pounds, the ammonia, amounting to about six and one fourth pounds, and a large quantity of water for each ton of coal and 120,000 feet of gas." For this purpose the gas must be cooled from six hundred degrees F. to a temperature at which water will condense. But, when the condensation has been effected, the tar and water assume a vesicular condition and remain suspended in the gas, precisely as fog is suspended in air under favoring conditions. Hence washing the gas by causing it to bubble up through water, or a scrubbing process similar to that carried out in gas-works, became necessary to complete the separation. The works at Gartsherrie use cooling and scrubbing. The plant has been improved, as we shall presently see, but the credit of inaugurating a successful industry is not the less due to the pioneers above named. The plant at Gartsherrie was first designed to deal with sixty million cubic feet of gas per day of twenty-four hours. Perhaps it ought to be here explained to lay readers that the operation of a blast furnace is continuous, sometimes extending night and day through a period of years, or until repairs are needed. Everything that goes into a blast furnace, except the blast, is in a solid state, and everything except the blast goes in at the top. All (except a negligible quantity of dust) comes out either in a liquid or a gaseous condition, the fused solid materials running out at the bottom. The Scotch furnaces are considerably lower than those in the Cleveland district, because the coal they are obliged to use will not sustain sufficient weight to allow greater height. Some of the Cleveland furnaces are one hundred feet in height. Scotch furnaces are now built about sixty feet high and from twelve to eighteen feet in diameter at the widest part. Now, as what goes into a furnace working continuously must equal in weight what comes out, a furnace making, say, three hundred and fifty tons of iron per week would receive per hour, say, five tons of forty per cent. iron ore, one ton of limestone, three and one-fourth tons of coal containing sixty per cent. of carbon, and about twelve tons of air. Out of this hourly charge the furnace will deliver, say, two tons of pig-iron and something over three tons of slag, and the rest of the total weight put in will pass out in gaseous form; about sixteen and one-fourth tons of gas will be delivered. If the composition of the materials could be exactly known, the exact weights of gaseous and liquid products respectively could be stated. The by-products which the new industry saves are the slag, the gases, tar, and ammonia. The gases—chiefly carbon monoxid, result from enforced imperfect combustion of fuel in the furnaces. They are now utilized as fuel after the water, tar, and ammonia have been separated. About twelve times as much gas is made from a ton of coal in a blast furnace as is made in gas works. In the latter the product results from distillation only, while in the blast furnace there are added the products of the combustion of the coke, and nitrogen from the air-blast. A furnace using eighty tons of coal per day yields more than nine million cubic feet of gas per day. It can now be understood that neither the plant first erected at Gartsherrie (which dealt with the products of eight furnaces) or the business pluck at the bottom of the new enterprise was an insignificant affair. The eight furnaces consumed, each, an average of from sixty to sixty-five tons of coal daily. Incidentally it may be remarked that the output of gas from the Glasgow gas works is daily less than that of two iron furnaces using each eighty tons of coal. When it is reflected that less than twenty years ago all this gaseous product, with its accidental contents, was allowed to go to waste and consume in the outer atmosphere, and when the vast number of iron furnaces in the different countries of the world is also considered, some faint idea of the magnitude and importance of the saving effected may be formed. The plant at Gartsherrie consists of an atmospheric condenser, a water-condenser, scrubbers, and exhausters. The atmospheric condenser is a system of tubes into which the gas is conducted at a temperature of about four hundred degrees F. and is cooled in its passage through them down to about one hundred and twenty degrees. Some tar is deposited in these tubes. The gas is then passed on to the water-condenser, an iron chamber forty-five feet both in length and height and eighteen feet in width. Here it is brought into contact with an immense cooling pipe, surface water being circulated through the pipes, and the gas, as it cools, passing over surfaces still cooler, till it has been cooled sufficiently to precipitate its water and tar, which assume the vesicular state above mentioned. It is then passed into the scrubber, a tower eighty feet high crossed by perforated sloping shelves. The gas enters at the bottom, and, passing up through the shelves and their perforations, is met by a descending shower of water, which carries down the substances it is desired to remove. To help the gas in overcoming the frictional resistance of the long and tortuous passage through the entire apparatus, exhausting fans or other forms of exhausting apparatus are employed. Root's blowers are commonly used. The gas is now fit for fuel, and it can be used either for steam generation or directly in gas engines. As already mentioned, this apparatus has been improved somewhat, but the general principle of separating accidental products and utilizing them by condensation is used in all the plants so far erected. The improvements are principally confined to details of construction and order of proceeding,—for example, washing before passing the gas into the atmospheric condenser, etc.

The tar yields lucigen oil and creosote oil, and the slag is made into paving blocks. The value of the by-products is estimated at about one-sixth of the value of the pig-iron out-put.

Welsh Anthracite Pig Iron.

UNDER the title, "Recollections of the Anthracite Pig-Iron Industry," Mr. E. Roberts contributes to the *Iron and Coal Trades Review* (Nov. 20) an article of more than ordinary interest. In it he alludes to the great furnaces of Yniscedwyn in Wales, once famous for their anthracite pig iron. The manufacture of anthracite g iron in Wales is now practically extinct. Should it ever be revived, the experience of Mr. G. H. Strick of the Amman Iron Works, near Swansea, as recorded in a series of articles printed in the *Iron and Coal Trades Review* in August and September last, will be of value. These articles described the manufacture, the furnaces, and the product. Mr. Roberts declares that Mr. Strick is the greatest living authority on the subject, and that he possesses a knowledge of the industry, gained by practice and experience, combined with technical skill, such as no other man possesses. He was the last to manufacture this iron in Wales, the industry having ceased in 1891. The Yniscedwyn works, with which Mr. Roberts was connected for many years, having been mentioned by Mr. Strick in his articles, Mr. Roberts asserts that Mr. David Thomas, formerly of Yniscedwyn, was the great pioneer of the American anthracite coal trade. An interesting incident anent the differences in quality between the Welsh and American anthracites is related. The master moulder at Yniscedwyn, having spent some time in the Crane Anthracite Iron Works at Cattasauga, Penn., and thus being familiar with the use of anthracite for iron-smelting, was requested to use the Welsh anthracite for the same purpose. To this request he answered that, while the Welsh anthracite was the better coal, "it was different from the American, especially in one particular,—namely, that the Welsh anthracite went to pieces in the cupola when heated, while the American held together, like coke." It is regarded as somewhat remarkable that a man who possessed no technical knowledge should have so sagaciously hit upon the vital fact that the adhesiveness of American anthracite coal contributes largely to its value as a smelting fuel under burden, while the Welsh coal, not possessing this quality to the same extent, although showing better results upon analysis, is less fitted for use in smelting. Mr. Thomas, above referred to, is quoted as authority for doubting that Welsh anthracite was used by itself for smelting prior to 1860. Mr. Thomas commenced its use admixed with coke as early as 1820. He then used one part of the anthracite in from twelve to twenty parts of coke; but he says that, "whenever anything went wrong with the furnace, the fault was laid upon the coal, and the men became so prejudiced against it that I had to give up. He continued to experiment, however, till 1825, in which year he had a small furnace built, and, after blowing it in with coke, he introduced anthracite, in gradually-increasing quantity. But it had to be abandoned on account of the filling up of the tuyeres. A furnace with a larger (eleven feet) back and a twenty-five-foot stack succeeded better, but was still unprofitable. About this time Mr. Thomas heard of the Neilson patented system of hot blast, and became anxious to introduce it in the Yniscedwyn furnaces.

To convince his employer, Mr. George Crane,—then owner of the Yniscedwyn works,—that this would be a good thing, he resorted to the following expedient. "He sought an interview with Mr. Crane in his house, and, while discussing the subject at the fireside, began to blow the fire with a pair of bellows. 'Don't do that, David, or you will put the fire out,' interposed Mr. Crane. 'If the air in those bellows was only as hot as Mr. Neilson describes his hot blast to be,' rejoined Mr. Thomas, 'the anthracite coal in that grate would burn like pine wood.'" This answer is said to have had the desired effect upon Mr. Crane. At any rate, Mr. Thomas was commissioned to investigate the system, and to obtain a license to use it in the Yniscedwyn furnaces, and, in 1837, a new furnace employing the hot blast was successfully blown in at these works.

In this furnace an anthracite iron was profitably made for many years. The introduction of the Siemens-Martin steel for the manufacture of tinplates in 1875—superseding puddled iron for this purpose—struck a death blow to the manufacture of anthracite iron in Wales. Strick, however, stuck to it till 1891. All tinplates now made in Wales are made from steel.

English Railway Accidents.

TRANSPORT has an interesting review of the board of trade statistics as to railway accidents in the United Kingdom in 1895, and finds, as a "first lesson," that "travelling in a railway carriage is just about as safe as walking down the street."

Taking the first statement presented,—"that only 5 persons lose their lives from causes that were beyond their own control during the entire year," while "the injured numbered 399,"—the conclusion might be formed that it was far safer than walking down the street, or even remaining quietly at home; for the total number of passenger journeys, exclusive of those by season-ticket-holders, was 929,770,909.

Such a record would be more than marvellous; and it is not at all surprising, therefore, to find that the item of 5 killed and 399 injured is only the first in a much more extensive railway death-list. It is immediately followed, in the abstracted table, by "accidents from other causes, including accidents from their own want of caution or misconduct," which caused 78 deaths and 710 non-fatal injuries. In addition, 65 persons were killed and 33 injured while crossing railways at grade; 285 "trespassers" were killed, and 144 injured; there were 96 successful attempts at suicide; and "miscellaneous" causes add 53 to the death-roll and 81 to the injury-roll.

These are all exclusive of employees or "servants of companies and contractors," of whom 12 were killed and 88 injured "from accidents to trains, rolling-stock, permanant way, etc.," and 430 killed and 2,566 injured "by accidents from other causes," including their own fault or negligence.

And still the list is not complete, for "the companies have returned 66 persons killed and 5,297 injured from accidents that occurred on their premises, but which were not connected with the movement of railway vehicles."

This swells the total casualty list to 1,090 deaths and 9,318 cases of injury, conveying a very different impression from the one given by the opening sentence. An extraordinary feature is the very large number of accidents occurring on railway premises, but "not connected with the movement of railway vehicles"; another interesting peculiarity is the extremely large percentage of fatal results in the cases of grade-crossers, trespassers, and would-be suicides.

The showing is, on the whole, an excellent one, and is most strongly to be recommended to the attention of our American roads. Unfortunately the comparison of the proportion of injuries to employees, which we expressed the desire to make in the October issue of THE ENGINEERING MAGAZINE, is not immediately possible, as the total number of employees is nowhere given. The total number of reported accidents to employees seems small,—442 fatal and 2,654 non-fatal,—even if we add the entire number of mysterious persons injured on railway premises, but not by the movement of railway vehicles. Supposing them all to be employees, it would give but 508 deaths and 7,951 injuries, while the figures in the United States for the year ending June 30, 1895, were 1,811 killed and 25,696 injured out of a total of 785,034 persons employed.

Examination of the English returns, however, forces the conclusion that they are so classified as to convey an impression unduly favorable to the companies, though this probably is entirely undesigned. For instance, among the employees suffering from "accidents from other causes, including accidents from their own want of caution or misconduct," there were 16 killed a nd 31 injured while coupling or uncoupling cars; 94 killed and 1,127 injured in other switching operations; 12 killed and 64 injured by being caught between cars; 9 killed and 54 injured by being caught between trains and platforms; 80 killed and 95 injured while working on permanent way or sidings; and 93 killed and 148 injured while walking, crossing, or standing on the line on duty,—nearly three-fourths of the number of casualties grouped under this head, strongly suggesting "contributory negligence," being thus directly traceable to the hazards of duty.

Finally, and (sad to say) in striking contrast with American figures for the same items, it is reported that 99 per cent. of signal and point levers throughout the United Kingdom are interlocked, and 94 per cent. of all vehicles in use have brakes complying with some or all of the board of trade requirements.

Management of Water Backing Through House-Drains.

We illustrate herewith an arrangement for the management of water backing through house-drains into cellars, which is liable to occur in low and flat towns, and to generate an intolerable nuisance. The method was designed and carried out in Croydon, England, by Mr. T. Walker, an engineer of that town. The description of it was first printed in *The Surveyor, London*, whence it has been copied into *Domestic Engineering* (October). The method seems simple and feasible, and worthy of a place among appliances for the sanitation of dwellings.

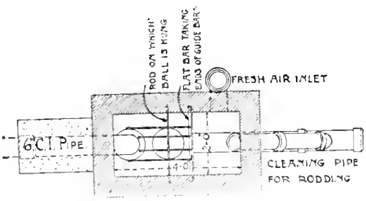


FIG. 1. PLAN OF MAN HOLE.

Fig. 1 shows the plan and Fig. 2 the sectional elevation of a man-hole chamber, receiving the drainage of four houses, through a 6-inch cast-iron pipe, delivering downwards; it is arranged to receive a stout rubber ball, fastened to a chain and arranged so as to find a seat at the mouth of the trap when water backs up through

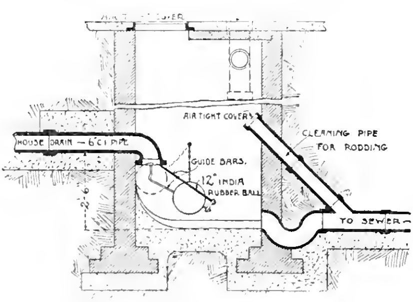


FIG. 2. SECTION OF MAN HOLE.

the sewer. The ball is lifted by the water, and forced by guide bars to its seat. These guide bars are shown in detail in Fig. 3.

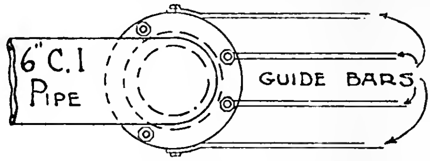


FIG. 3. DETAIL OF GUIDE BARS.

Fig. 4 shows the position of the ball when raised. No further description is needed to explain the action. The chamber receives all the back water, while the drainage acquiring a small head in the house-drain will force its way past the rubber ball-valve and into the chamber, passing

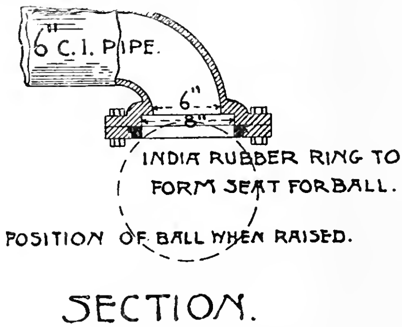


FIG. 4. SHOWING THE BALL RAISED.

thence into the sewer. Of course proper care must be exercised in constructing the chamber, or cistern, which should be proof against leaking; otherwise there will simply be the substitution of one nuisance for another.

Idle Electric Currents.

The multiplication of technical terms seems to be a fad with some writers on electricity. A new term can not be objected to when it exactly supplies a need in expression, or even when it gives us a better facility for conveying ideas than has been previously possessed; but, when there is no such need, and all a new term can have to its credit is its novelty, we think the practice of word-invention should be condemned. Such an apparently unnecessary term, "wattless," is used in an article in *The Electrical Review* (London, Nov. 20). What is expressed by the term "wattless currents" that is not as well expressed in the term "idle currents" used in the title, we fail to perceive, even when we carefully scan the definition given by the writer. "A wattless current," he says, "is a current having *the same periodic time* as the electromotive force, but differing in phase by a quarter of a period. This definition," he explains, "excludes currents of a different periodic time—higher harmonics of the useful current which neither contribute to the energy developed by the useful current, nor have the deleterious effects of the wattless current." Exactly so, but what more do we know, or can we know, about these currents by calling them wattless, than by calling them "witless"? We know that these idle currents "do not in any way contribute to the distribution of energy," but the term "wattless" does not seem to help us to this knowledge any more than the term "horse-powerless heat" would aid us to understand that heat radiating from a boiler, steam-pipes, and steam engine cylinders inside and outside does not contribute to the desired distribution of mechanical energy. But, waiving this criticism of what we think a superfluous technical term, we pass to a criticism which the writer of the article makes upon a paper read by M. Blondel at the Congrès International des Electriciens, Geneva, 1896, which is that, in that discussion of the question, M. Blondel disregarded altogether "the convenience of the consumer" . . . "in stating that the lagging current is all-important," and considered "merely the economy and ease of the conduct of the supply station." The position is taken by the *Electrical Review* critic that, "provided the consumer uses a watt-meter or an erg-meter, the presence of a wattless component of the current is usually of small importance to him, so long as the heating effect is not excessive." The critic admits that the regulation of generators is rendered extremely difficult when there is a large lagging current, but calls attention to the fact that, when "there are alternating synchronous motors on the distributing mains, a leading current will interfere with their regulation." It is urged that a lagging current weakens the field of a generator and strengthens the field of a motor, while a leading current weakens the field of a motor and strengthens the field of a generator. Therefore leading currents should be considered of importance as well as lagging currents. Idle, or wattless, currents are characterized as "perhaps the greatest difficulty in the distribution of electrical energy by alternating currents, the lagging currents acting deleteriously upon the regulation of the generators at the central station, and increasing the heating of the circuit." M. Blondel's critic admits, however, that "the regulation of the generators is the more important, since they have to supply current for lighting purposes as well as for motive power"; but, if any synchronous motors be on the circuit, the leading current becomes a factor whereby the fields of such motors are weakened and their load-limits diminished. The aim should be to "have the current in phase with the generator E. M. F.," without which neither the supply company or the consumer can be pleased. The article concludes with the opinion that the suppression of these idle currents may be reached (as believed by M. Blondel) by possible improvements in generators and motors, such suppression being "one of the most important problems in electro-technology."

The Navies of England, France, and Russia.

A PARLIAMENTARY return of the fleets of the chief naval powers presented to the house of commons during its last session, but only recently printed and published, furnishes material for a well-prepared review in *The Engineer* (London, Nov. 13). The fleets of Great Britain, France, Russia, Germany, Italy, and the United States are classified in the report as follows: (1) battle-ships built and building; (2) cruisers built and building; (3) coast-defence ships; (4) torpedo vessels, catchers, and boats. In our contemporary's review of this report the second class is considered as consisting of cruisers and protected cruisers. Of armored battle-ships, England has forty-five afloat and twelve building,—a total of fifty-seven. Sixteen of these battle-ships have heavy armaments of muzzle-loading guns. France has twenty-nine battle-ships floating and six building. Russia has ten battle-ships afloat and nine now building. The Russian and French fleets, afloat and building, and armed with breech-loaders, would, if combined, outnumber the British ships similarly armed, showing fifty-three to Great Britain's forty-one, and, counting those armed with muzzle-loaders, the combined Russian and French fleets equal the entire British fleet. From these facts *The Engineer* enters upon some curious calculations, in which the question of the strength of fleets is considered wholly from a mechanical standpoint, "the man behind the gun" being left entirely unconsidered. "A ship's power of artillery attack is considered as proportional to her total energy of fire per minute." It is also figured out that the tonnage of the British battle-ships is thirty-one twenty-fifths as much as the combined tonnage of the Russian and French fleets. *The Engineer* assumes it to be certain that the Russian and French fleets would act together in case of a European war, and, as their combined strength appears to be about equal to that of the British fleet, this condition is regarded as serious, and is so discussed. The armored cruisers of England, Russia, and France are next considered. Of these, Great Britain has eighteen, with a total displacement of 137,050 tons; France has ten, including one now building, with a total displacement of 60,716 tons; and Russia has, afloat and now building, eleven, with a total displacement of 82,273 tons. Combined, the cruiser fleets of France and Russia are distinctly stronger than the cruiser fleet of England. At the same time England is very strong in protected cruisers, of which she has afloat and under construction one hundred and sixteen, while France has thirty-seven and Russia only two. Of these our contemporary remarks that "among English ships of this class are some very powerful vessels, including the Powerful and Terrible, each of 14,000 tons, and four of the Diadem class building, of 11,000 tons. These vessels are practically more strongly protected than most armored cruisers." Of coast-defence armored ships England has fourteen, while France has fourteen and Russia sixteen. England has thirty-five torpedo vessels; Russia has sixteen and France thirteen. England has one hundred and one torpedo boats as against two hundred and twenty French and one hundred and sixty-two Russian. Of torpedo-boat destroyers England has built and building ninety-one. It almost takes one's breath away, after thus surveying the vast naval power of Great Britain, to hear it urged that it must be further increased; but this is precisely what our contemporary says must be done. In case of war "England would hope so to keep the sea as not to need large numbers of coast-defence ships and small torpedo boats. England, probably, on the whole, stands at least as well, compared with France and Russia as she has at any time for many years past; nevertheless, with the relations now existing between France and Russia, it is of vital consequence that she should be strong at sea, and for this cause a forward decided naval policy should be followed." From this it is indicated that Great Britain can not feel safe with a naval power less than that of such nations as are likely to combine their fleets in event of war. Hence, in a protracted time of peace, preparations for war are actively kept up in British dock-yards, and there is no indication when and where this will end. The one phase of this activity that can be regarded with unmixed satisfaction is the fact that all this ship-building, armoring, and arming provides an enormous amount of work for a worthy class of mechanics.

Breakdowns of Stationary Steam Engines.

An experience of twenty years in the inspection and insurance of steam engines ought to afford opportunities for collecting a large store of information upon the subject of faults in construction and defects leading to breakdowns. It is from such an experience that Mr. Michael Longridge, of Manchester, England, draws in a paper with the above title, printed in *The Colliery Guardian* (Nov. 13), and read before the Institution of Mechanical Engineers November 5, 1896. The paper is largely statistical, and, in such a notice as the present, some of its most salient points only can be dealt with. The statistics are compiled from a list of the last one thousand breakdowns with which the author had to deal prior to 1895. While this number is, perhaps, too small to be accepted as a basis from which to draw general conclusions, it is certainly large enough to afford very fair ideas of breakdowns of stationary engines in English practice. A running commentary of hints relating to causes of breakages and means of avoiding them accompanies the tables, and the paper is in every sense a valuable contribution to the current literature of mechanical engineering. The breakdowns are classified. One table pertains to parts which appear to have broken first. Out of the one-thousand breakdowns this table shows that of valves and valve-gear there were 213; of spur wheels, 124; of air-pump motions, 121; of air-pump buckets and valves, 88; of columns, entablatures, bed-plates, and pedestals, 86: of main shafts, 89; connecting-rods, 41; cylinders and valve-chests, 35; parallel motions, 35; governors and governor-gears, 28; piston rods, 27; piston-rod cross-heads, 27; pistons, 22; links, 22; fly-wheels, 19; air pumps and condensers, 13; cranks, 12; gudgeons in beams, 12; crank pins, 11; beams, 6; slide bars, 5; ropes, 3.

Lastly, the list is rounded up with an engine that, like the famous "one-horse shay," went to entire smash, but, unlike that admirable vehicle, instead of being made equally strong in every part, appears to have had a uniformly-distributed weakness. No other cause for this complete smash was ascertained. This preliminary table is followed by another, which gives the total number of breakdowns of valve gear, and the number of breakdowns due to specific and well-ascertained causes. Thus 46 valve-spindles were broken,—34 on account of weakness of screw threads, and 12 from sundry causes not named. Of eccentric straps there were 24 breakages, 8 of which were due to weakness, leaving 16 unaccounted for specifically. So on through the list of 213. Of the 124 spur-gearing breakages, 23 were due to back lash from belt or rope drums on "second-motion" shafts; 19 were attributed to vibration caused by high speed, heavy load, insufficient fly-wheel, and small pinions; 16 were from excessive stress due to teeth bearing on their corners and up to their points; and 11 are assigned to high speed and irregular pitch. Bolts or pieces of broken teeth getting between the wheels caused 10 breakages. The rest of these wheel breakages were due to a variety of causes, some of which were not ascertained. It is explained that the term "backlash" is used by Mr. Longridge in the sense understood in Yorkshire and Lancashire, England, "which includes not only backlash proper, but also break of contact between the working faces of the teeth of the two wheels when the driven wheel runs faster than the driver." What is called the "second motion" shaft, in Lancashire, is a shaft carrying a pinion geared with the driving wheel.

Mr. Longridge deprecates as dangerous the practice of placing rope or belt drums of any considerable size on shafts driven by spur-gearing, explaining why it is dangerous. "Such drums" (in England) "are often put upon second-motion shafts to replace existing gearing or to drive additional machinery. As they have generally to be got into existing buildings where there is little room to spare, there is often a temptation to keep down their width and run them at high circumferential speed. This alone is sufficient to make the pinion on the second-motion shaft overrun the spur-wheel on the main shaft of the engine; but, when, in addition, the ropes or belts bounce, as they sometimes do if long, unless the engine has a powerful fly-wheel the effect is sure to be disastrous to the gearing. In fact, it may be safely stated that heavy rope- or belt-driving should never be placed in sequence to spur-gearing, except after special investigation by a competent engineer fully aware of the risk incurred." The nineteen wheels the breakage of which is ascribed—as above stated—to vibration were really broken on account of a kind of wear and tear, which Mr. Longridge thinks peculiar to large segmental rim spur-gears, as they were all of this kind, and, except in a single instance, transmitted 1,000 or more. The author says it is impossible to describe in detail the causes of this destructive jar, but from his description, it appears to arise from imperfect workmanship, more particularly in the form of the teeth, which in most cases appear to have been machine-molded. He therefore advises the avoidance of wheels of this design under conditions of high power and velocity ratio.

Portland Cement Admixtures.

CERTAIN admixtures of ground stone, slag, etc., with Portland cement having been claimed not to injure, but, on the contrary, to actually improve, its quality, Mr. D. B. Butler, at the conclusion of a paper read by him in 1895 before the (British) Society of Engineers, declined to express an opinion as to whether or not this claim could be sustained. He stated that he was at that time prosecuting a series of experiments upon the subject, the results of which would enable him to speak to the point with greater certainty, and that for this reason he would then reserve his opinion. At the meeting of the society held November 2, 1896, he presented the results of the experiments in tabulated form, together with photographs of sections of concrete made with cement containing slag, clinker, and Kentish ragstone, the latter having been claimed by one cement manufacturer to be an actual improvement, and as such improperly called an adulterant. "Kentish rag" is a local name for a sandy limestone . . . extensively quarried near Maidstone, England, and elsewhere, and used for building and road-making. The paper describing the experiments and their results in *The Engineer* (Nov. 6) does not present the tables, but states in a general way some of the peculiarities of such admixtures. The rag-stone used in the tests was analyzed, and found to contain: water, 1 part; insoluble siliceous matter, 7.28 parts; soluble silica, 2.75 parts; alumina, 3.7 parts; oxid of iron, 3.34 parts; carbonate of lime, 80.69 parts; carbonate of magnesia, 0.56 parts. These numbers amount to a fraction more than 100 parts, but we give them as tabulated in *The Engineer*. Rag-stone purchased at a Maidstone quarry was ground to a fineness which left a residue of 31 per cent. on a 180 sieve, 25 per cent. on a 120 sieve, 9.8 per cent. on a 76 sieve, and 3 per cent. on a 50 sieve. This stone was then added to ordinary Portland cement in quantities ranging from 2 to 50 per cent., and the tensile strength was tested in the usual manner, at dates ranging from seven days to twelve months. When gaged neat, the admixture did not seem to materially affect the strength, some specimens seeming to indicate a slight gain, especially at the earlier dates; but, when gaged with three parts of standard sand, the adulterated cement gave a lower result than the pure cement in nearly all cases. When 15 per cent. of ragstone was added, it was found that the injurious effect was much intensified when the cement was left entirely in the air, and also when it was exposed to sea-water. Fifteen per cent. of the ragstone was used, because this proportion was about that recommended by the advocates of ragstone. This admixture was further tested in comparison with cements made by three other manufacturers, tests of two of which cements were carried to three months only, while the third was carried to the end of twelve months. These tests confirm the results of the other experiments. When tested neat, the admixture showed no material effect upon the strength, except that in some instances a distinct gain was manifested. But, when tested as a mortar with three parts of standard sand, the strength was reduced from 6 to 14 per cent. The ultimate conclusion arrived at, is, that any admixture of inert materials not readily soluble in water, "or reduced to an absolutely impalpable powder, so that it can be acted upon by every particle of the cement," lessens the cementitious value, and becomes a source of weakness. Methods of detecting the presence of these foreign substances are also dealt with. The author strongly recommends the microscope as an invaluable aid thereto.

FRENCH AND GERMAN PRESS

We take pleasure in announcing that, beginning with this number of the magazine, we have arranged to comprehensively review, and to add to the index, the leading articles in all the important French and German industrial periodicals.

Owing to the necessary delays and formalities of effecting so many exchanges, the work in this direction is not yet as full as it will shortly be. Its speedy completion will place at the command of our readers practically the entire range of the technical literature of the world, and will make the REVIEW AND INDEX OF THE ENGINEERING MAGAZINE the most elaborate and exhaustive work of its kind which has ever been attempted.

Germany's Electrical Progress.

Mr. SCHEFFLER, the chairman at the opening of the winter session of the "Elektrotechnische Verein," reviewed, as usual, the progress of the past year. The number of lamps connected to the various central stations has been increased by about twenty per cent, while the supply of power has been increased since the last publication of central-station statistics by 7,336 kilowatts, which corresponds approximately to 150,000 normal lamps. A point of greater value to the community, however, is the considerable decrease in price to the consumer. While in some places 50 pfennigs (12½ cents) are charged per k.w.h., up to 400 k.w.h., the charge for power above that number is but 2 pfennigs per k.w.h. Thus real advantage is gained only if the consumers utilize current for other than lighting purposes. The central station thus offers inducements for day loads, being enabled to run stations at a more uniform load.

In mining and in the running of machinery for general heavy work, electricity has proven itself a most valuable agent during the past few months. The Salt mine, "Luneburg," is an excellent example, since the rope drives which worked the pumps have been replaced by dynamos and motors driven from an engine. Although the amount of coal used is not more than it was in former years, the company can run 12 h.-p. motors for their workshop and 500 incandescent lamps.

The ship of Emperor William, "Aegir," has been electrically equipped.

Possibly much of the financial success of some of the electrical roads is due to the fact that lighting and power stations are run together. In Germany this appears to be an indisputable fact, while in the United States this has not always shown itself desirable. Electrical control of switches is now an accomplished fact. Entire streets can be so arranged that an accident happening to any one car will bring all the cars immediately to a standstill.

The utilization of the 500–600–volt direct current has been constantly increasing; in fact, the activity in electric railroad construction in Germany is steadily growing. The fact that but 872 kilometers are at present in existence, while 855 kilometers are at present in course of construction, is sufficient evidence for this statement. Even in railroad work the rotary current is finding favor, to which the Lugano (Switzerland) road bears witness.

The lighting of the mail-cars by electricity is another step in advance. Accumulators are used throughout, and fifty per cent. of the mail-cars—that is, about 800 in all—have been fitted.

The rotary current has been freely introduced of late, on account of the ease with which motors may be run. The "Drehstrom" motors are distinguished by the absence of brushes, thus making their maintenance easy. The only trouble—which up to the present is intrinsic in this class of machinery—is the great loss of power in the regulating devices. Special attention should be devoted to the important problem of absolutely non-synchronous motors.

The utilization of water-falls has made considerable progress during the past twelve months. and the works at Rheinfelden, for 15,000 h. p. with 6,800 volts, deserves special mention. The culm is now being made use of for the first time, the firm of Siemens & Halske constructing a plant at Johannesburg which transmits energy through a distance of 45 kilometers. Another of 25 kilometers in length is being put in operation in Upper Silesia.

Dynamos whose total capacity amounts to several thousand horse power have been put in operation for the electro-mechanical industry.

Investigations of the last few years show that large networks of electrical conductors tend to weaken the violent action of thunderstorms, and to decrease the danger from lightning.

A number of large stations have replaced their batteries by accumulators. The total length of the telegraph lines has increased from 144,638 to 150,906 kilometers, and that of telephone lines from 643,743 to 709,211 kilometers.

Mining and Metallurgy in Upper Silesia.

THE real basis of the Silesian industries is the mineral wealth of the region. It contains principally zinc, lead, iron ore, and coal. Coal is found not only near, but in many cases with, or in strateral layers above or below, the minerals. Without this easy access to coal neither the iron industry or metallurgical works could exist. The total area occupied by these large coal-fields amounts to about 5,600 square kilometers. Dr. Fr. G. Bremme, who recently delivered a lecture before the "Verein Deutscher Eisenhüttenleute" (Society of German Iron Miners and Metallurgists), explained in detail the position and condition of the principal veins of iron ore and coal throughout that country, showing ease of access as well as convenience in transportation.

The quality of the coal found in the central region is extraordinarily pure, the amount of ash being very low. The quantity of sulphur found usually does not exceed one per cent. For the coking process, however, the country is not in good condition. Out of 18,000,000 tons produced in 1895 but 2,000,000 tons were of the fat and open-burning coal. Of the so-called fat coal 1,580,000 tons were turned over to the coke establishments, the remainder, 420,000 tons, going to the gas plants. The utilization of non-coking coal for coal-dust-brick (briquettes) is effected only in two installations. The most important fat coal in Silesia is composed of the following elements: carbon, 79.57 per cent.; hydrogen, 5.01 per cent.; oxygen, 9.48 per cent.; nitrogen, 1.10 per cent.; sulphur, 80 per cent.; ash, 4.84 per cent. In the blast furnaces in 1895 1,241,000 tons of ore were melted. The total production of pig iron is 568,000 tons. Eleven works, with twenty-six furnaces, are in operation. The record of production for one furnace for one day is 110 tons. Several works remove their slag with locomotives, while but a few years ago horses and even men did this work. Gas-firing has, in several places, been successfully introduced. The author concludes with a reference to the conditions of the working classes in the neighborhood. In the Silesian district 103,245 people are employed, of whom 66,348 work at coal and ore mining, 9,539 in zinc, lead, silver, and allied works, and 27,358 in the iron and steel industry. Of the employees 11,500 are women. In this densely-populated district there is little demand for household duties, and most of the female employees are girls or widows. The salaries paid to men, women, and boys under sixteen years of age were, for the past year, as follows: men, 788.51 marks=$147; women, 322.60 marks=$80.60; boys, 319.24 marks=$79.81.

Longitudinal Sleepers in Austria.

FROM a paper on "Permanent Way" read before the International Railway Congress by W. Hohenegger, and printed in the August number of the *Bulletin of the Congress*, *The Railway Review* (Oct. 31) reprints an account of experiments made with longitudinal sleepers, "undertaken on account of the difficulty of holding the track in position on sharp curves when the speeds of trains were increased." The curves of some of the sections of the road whereon the experiments were made comprise fifty per cent. of the whole line.

"The form decided upon for the experiments employed two lateral flanges made of wrought iron. Two and one-half-miles were laid in 1876. The length of the sleepers in this experiment was 31 feet 10 inches, the weight being 52 pounds per yard. At the joints of the sleepers cross-tie supports were used, which were similar in section to the longitudinal sleepers. The rail weighed 54 pounds per yard, and at intervals of 32 feet two tie bars were passed through the webs, but these were afterward removed. The cross-ties soon gave place to lighter angle irons, on account of the oscillations which were imparted to the cars by the stiff ties. The total weight of this track construction was 250 pounds per yard, and the cost was about $5 per yard more than that of the ordinary construction on wooden ties. This trough construction has been in use on a section of track along the Danube for twenty years, and now requires renewal on account of wear."

In relaying, a system employing stronger rails and sleepers was adopted. But of the results of the twenty years' experiment with the sleepers above mentioned the following particulars are presented.

During the whole twenty years of the first experiment there has not been a fracture of a sleeper or an actual rail fracture on either of the two experimental sections, while, on the adjoining sections laid with wooden ties, the rails had to be replaced after from twelve to fifteen years' service. The rails on the longitudinal system have already lasted twenty years without exhibiting any material damage at the joints.

"The price of the structure, when made of piled wrought iron, was high, and, on account of having a large number of weldable Scotch iron rails on hand, an experiment was made with longitudinal troughs made of the old rails, which were welded together at the head and rolled into the desired trough section. Thirteen miles of this form of support was put into service between 1877 and 1880, the cost being approximately the same with this construction as with the wooden sleepers. In this construction, the length of a trough could be made up to a length of sixteen feet, the cost being about $5.20 per yard of permanent way. In the experiment angle irons were used as cross-ties. The rails weighed fifty-four pounds, and, as the experimental section is now considerably worn, it is being removed and relaid on the cross-tie system." Attention is also directed to the great advantage of iron longitudinal sleepers as compared with wooden ones; for, while wooden longitudinal sleepers would have become utterly useless, by decay or mechanical destruction, in the course of twenty years, the iron sleepers are still so well preserved as to be likely to last another twenty years in the station sidings, where the running is slow. Wooden sleepers would probably have to be renewed throughout at the end of fifteen or twenty years, including most of the fastenings; whereas, in the case of the iron permanent way,—the first cost of which is not materially more than that of the other,—nearly all the parts can be used over again.

The Latest Discoveries at Tungad.

ALBERT BALLU, chief architect of the Algerian monuments, states in a report that extremely valuable work has been accomplished during the past year at Tungad (Algiers). Judging by the excavations made, which offer an opportunity of investigating the construction of buildings and roads, the time of destruction can be determined within two centuries. It has been found that one house usually stood on a piece of ground of about four hundred square meters in area. The complete report appeared in *L'Ami des Monuments*, No. 55, vol. 10.

An Underground Road in Budapest.

AUSTRIA-HUNGARY has long been pre-eminent for progressiveness in mechanics, particularly in the exploitation and adaptation of the newer inventions and discoveries.

Indeed, the people of the double empire have been called the "Yankees of Europe," and from present indications they seem to more than deserve their pseudonym. We are so accustomed to believe in our unapproachable supremacy in the inventive and mechanical world that we are in some danger of sleeping on our laurels; witness our strange inattention to the horseless carriage and the water-tube boiler. And there are some hints that Austro-Hungarian developments in the electrical field might profitably be watched by us.

But now comes the news that, while we are yet struggling with the idea of an underground road, as if it were an unheard-of and doubtful proposal, Budapest is celebrating the opening of an electric underground line two and a quarter miles long, following for the most part the line of Andrassy street, "the most beautiful thoroughfare in Budapest," and that "the public has taken favorably to this road, a fact largely due doubtless to its smooth and noiseless working and very neat equipment."

The following notes are taken from the *Electrical World*.

"The road is 3¾ kilometers long (2¼ miles), of which 3.22 kilometers consist of tunnel and .53 of a kilometer surface road, and has walls one inch thick finished with beton. It is 3¼ meters deep, measured from the surface of the street. The inner clear height is 2.65 meters and the clear width 6 meters, thus leaving sufficient room for both tracks and for the necessary iron columns which support the upper portion of the tunnel. The largest grade is one in fifty, and the sharpest curves have a radius of 40 meters. The road is double track of standard width, and is provided with loops at both ends. Drain pipes run under each track for the purpose of carrying off all water which may collect in the tunnel. The top of the tunnel is constructed of iron and beton, the I-beams being held together by means of bolts and screws. The columns carrying the roof are four meters apart, and rest on foundations of beton.

"On the top of the columns, and running lengthwise with the tunnel, are two I-beams each 320 (milli?) meters deep when supporting a wooden pavement above, and 350 (milli?) meters deep when supporting a stone pavement. These beams also aid in supporting transverse I-beams placed one meter apart, the opposite ends of which rest on the side walls of the tunnel. These transverse beams vary in height according to the required carrying capacity, and they are either 300, 320, or 350 millimeters deep. The intervening spaces between the cross-beams are filled with beton, an extra layer of which increases to 10 centimeters in thickness, and is put in for the purpose of obtaining a slight curvature on the pavement above. The whole tunnel is completely surrounded by layers of asphaltum-felt plate for the purpose of making it completely water-tight. Gas and water pipes which were met with during the process of construction were partly run below the rails and partly alongside the tunnel."

The stations, which are about 300 meters apart, are described as generally similar to those of the London underground, with platforms serving trains in one direction only. There are no platforms between the tracks. The power-house has four boilers "with combined heating surface of 268 square meters, and two sets of engines of 600 horse-power each, driving multipolar generators."

The equipment at present consists of twenty motor cars and ten trailers; the cost of the road is given as about $1,250,000.

Fenders For Electric Street Cars.

THE city of Hamburg has appointed a committee of prominent engineers to investigate the question of fenders. The conclusions these gentlemen have arrived at are not by any means encouraging; in fact, they find, after investigating every European fender as well as one hundred and thirty-three of the principal American fenders, that no adequate system has as yet been proposed. The chief point brought out in the argument is that almost every fender requires the personal attention of the motorman, whereby the usual personal equation is added to the already difficult problem. For the motorman to appreciate the danger, to put his hand to the particular device, and to work the same will take more time than would ordinarily be practicable. If the fenders are too near the ground, they are apt to strike in case of the car getting into a state of vibration. Should they be too high, the person whom it is intended to save may be most seriously hurt, as he is liable to be crushed in addition to being run over.

Utilization of Refuse.

BUDAPEST, one of the most progressive cities on the European continent, owes not a little of its prosperity to the strict enforcement of its sanitary rules. The city has made a contract, dating from January 1, 1896, with Mr. Ludwig v. Cséry, in which the latter party guarantees to remove all city refuse within closed carts to the suburbs. The method of transportation as well as of utilization being unique, we give the following details: The wagons are conveyed by horses to one of the suburbs, where they are lifted off the truck and put on a flat car by means of a traveling crane. This flat car is taken out a considerable distance by a steam locomotive and lands the refuse near a manufacturing establishment, where it is mechanically assorted and the more volatile material burned under a boiler which supplies fifty h. p. to an engine, to which a 3,000-volt three-phase generator is directly coupled. The electric current thus generated is utilized to run the crane above mentioned, and is transmitted to that point by means of two regular trolley wires, with the earth as a third circuit. The machinery in this station runs several other power circuits, and furnishes light to the entire colony. The *Elektrotechnische Zeitschrift* (Oct. 15) states that another 100-h. p. engine will be installed shortly.

Annual Report of Zurich Electricity Works.

AFTER the completion of the electric installation, the management turned its attention to the equalizing of the load line. This was effectively accomplished by an accumulator sub-station. Since the consumption of electric energy rose within one year to such an extent that even the reserve machines had to be called into service, the company is under negotiation for an additional 600-h. p. generator set. Additional accumulator sub-stations will also be erected.

With the present amount of machinery, the plant is capable of developing 5,256,000 kilowatt-hours, while actually 918,095 kilowatt-hours, or 16 per cent., were furnished. Four per cent. were utilized for excitation of the generators. Between the current indicated at the switchboard and that paid for and recorded at the consumer's premises a loss of 29 per cent. was noted. This is considered to be principally due to transformer losses.

Considering lamps and motors used by private consumers in terms of lamp-equivalents, it was found that, under an average generation of 729 kilowatt, 466,963 kilowatt-hours were consumed. This shows an average utilization of 590 hours per lamp per year, or about 1 hour and 36 minutes per lamp per day. It is interesting to note in this connection that the average utilization of every lamp connected to the Edison system in New York City is about 1 hour and 15 minutes per 24 hours. It might be mentioned that the *Elektrotechnische Zeitschrift* of October 22 gives additional data from the Zurich station annual report.

Electrolysis Due to Trolley Currents.

IN a very careful manner this subject is treated by Mr. A. Monmerqué in a concluding article in *L'Eclairage Electrique* (Oct. 10). The English board of trade has established a rule that but five volts drop shall be allowed in the return circuit. This the author believes to be an unnecessary rule, since each case requires special attention; for example, it is not essential to prevent earth currents if no pipes run parallel to the rails and if not too many pipes are crossing. Rails being used for a return, their electrical as well as mechanical resistance should be examined. This precaution in the beginning will, in many cases, make additional copper return unnecessary, as the rails alone, if well bonded, will have sufficiently low resistance.

Among the problems to which the electrical engineer should devote special attention may be mentioned these: experimental determination of the value of the different systems for bonding rails, with a view to maintaining high conductivity; the resistance of the soil under different conditions; value of building rails on an isolated foundation; practical results obtained with the three-wire system.

Iron Industry in France during the first half-year of 1896.

The following, compiled from the *Comité des Forges de France*, will be of interest to many:

1. PIG IRON.

	1st Half-year '96.	'95.
Puddled iron.	893,909 tons	763,942
Foundry pig and cast iron.......	252,685	228,482
Total........	1,146,594	992,424

The total production is 15.5 per cent. greater for this year than that for the same period last year.

2. WELDED IRON.

Rails	417	181
Commercial iron....	347,885	340,584
Sheet iron..........	43,364	51,011
Total.........	391,666	391,776

3. STEEL.

Bessemer...........	338,436
Martin........	199,811
	538,247

This is, in total, 129,558 tons more than was produced during the corresponding period of 1895.

Aluminum on Warships.

EXPERIMENTS at the imperial navy yards at Wilhelmshafen have shown conclusively that aluminum cannot be used practically in men-of-war construction, while aluminum bronze has turned out satisfactorily in many cases, when the alloy contained 94-96 per cent. of aluminum and 6-4 per cent. copper. After investigating and testing aluminum in certain parts of vessels, the following conclusions were arrived at. Aluminum bronze is useless for bearings, valves, etc., on account of the rapid wearing away; it has been found useful, however, for various parts of machines where friction is not an important factor, and also in cases where light weight is an object. Furniture made of aluminum showed decidedly too little resistance and required frequent repainting, aluminum shows, furthermore, but little resistance to sea-water, thus making it useless for the walls of vessels. A 10 per cent. aluminum bronze, however, stands a fair chance of being freely used as soon as the price of aluminum can be sufficiently reduced to approach the value of cast steel.

A Century of German Coke Blast-furnaces.

ON September 21, 1796,—that is, one hundred years ago,—the first coke blast-furnace was put into successful operation. On November 10, 1796, the first practical coke pig iron was turned out, and the furnace remained fired for twenty-four weeks. Mr. Fritz W. Lürmann, who delivered an address on the above subject before the annual meeting of the German Iron Miners, gives details of all the following furnaces, which, after the first successful experiment, followed with considerable rapidity. It is interesting to note the constant increase in size.:

Year.	Name and Place of Furnace.	Height mm.	Furnace top mm.	Upper part of boshes mm.	Width of Hearth mm.	Contents. cbm.
1796	Gleiwitz..........................	12,900	1250	3450	800/600	49.83
1804–1808	Königshütte....................	13,300	1220	3660	915/585	51.91
1834	Sayner Hütte, with air blast.	10,690	1045	2825	785/497	29.49
1840	Königshütte......................	15,240	1830	4270	815/355	104.04
1850	Königshütte......................	15,665	1880	4700	1255/785	112.64
1853	Hörde	16,065	3140	5020	1250/945	169.24
1855	Haslinghausen	14,130	2825	4920	2200	176.88
1865	Ilseder Hütte..	17,445	3800	5000	1886	208.59
1860–1870	Königshütte.....................	15 535	3765	4920	33000/2197	207.02
1867	Georg-Marien Hütte..........	17,108	4184	5178	2196	219.10
1876	Gutehoffnungs Hütte.........	21,000	3400	5500	2100	293.45
1886	Hörde...............................	19,150	3500	6000	2500	325.56
1888	First coke oven with free hearth..........................	23,000	4050	64,000	3100	434.03

German Mining Salaries.

TO the statistics published in *Zeitschr. für das Berg, Hütten und Salinenwesen* on the quantities of various materials mined during the first half of this year, there is attached a list of salaries paid to the miners in the principal sections of Germany. It shows, on an average, a net earning 2.13 marks per day, or 53 cents in American money.

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THE PUBLICATIONS REGULARLY REVIEWED.

Age of Steel, The *w.* $3. St. Louis.
American Architect, The *w.* $6. Boston.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $.4 New York.
Arena, The *m.*, $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin.
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.

Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
L'Eclairage Electrique. 60 fr. Paris.
L'Électricien. *w.* 25 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver.
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8s. London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wisconsin Engineer. *yr.* Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 20 marks. Vienna.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

9184. The Great Scaffolds of the Congressional Library, Washington, D. C. (Brief illustrated description of this beautiful building, with cuts showing the method adopted for giving access to the interior surface of the dome). Sci Am—Nov. 14. 900 w. 15 cts.

9203. The Steel Arch Roof for the Chicago Coliseum (Illustrated description of a steel roof of great magnitude. General arrangement, composition and some details are given). Eng News—Nov. 12. 1800 w. 15 cts.

9278. The Youngstown, O., Bank Building (Illustrated description of a handsome building of fireproof construction). Eng Rec—Nov. 14. 2800 w. 15 cts.

9332. The Influence of Steel Construction and Plate Glass Upon Style. Dankmar Adler (One of the series of papers on this subject read before the A. I. A., at Nashville, Tenn. Denies that the art of architecture ended with the Renaissance; denies that new materials and processes are incompatible with truly artistic work; thinks the influence of the new materials will tend to a more free treatment of architectural design). Arch & Build—Nov. 21. 2700 w. 15 cts.

9345. Roof Coverings—Slates. Thomas Stirling, Jr. (Read before the British Arch. Assn. An extract relating to the Westmoreland and Cumberland slates). Brit Arch—Nov. 13. 3800 w. 30 cts.

9346. Roof Coverings — Tiles. F. Walker (Read before the British Arch. Assn. On the selection and setting of tiles used for roof coverings). Brit Arch—Nov. 13. Serial. 1st part. 2000 w. 30 cts.

9362. Copper, Lead and Zinc as Materials for Roofing. G. Ewart (Read before the British Arch. Assn. Advantages of sheet metal over slate and tiles are presented, and a comparison of the claims of each of the three metals). Arch, Lond—Nov. 13. 3000 w. 30 cts.

9439. The Influence of Steel Construction and of Plate Glass on the Development of Modern Style. G. F. Newton (One of the series on this subject read before the Am. Inst. of Arch's at Nashville, Tenn. Defends the high building, and thinks the effect of these new materials on style must depend largely upon the instinct and artistic training of the architect). Arch & Build—Nov. 28. 1800 w. 15 cts.

9443. Revolving Palace for the Exposition of 1900 (Brief illustrated description of novelty suggested for the French exposition, credited to M. Charles Devic). W. Elec—Nov. 28. 700 w. 15 cts.

9450. The New Edinburgh Fever Hospital (Brief description of some of the principal buildings of a new hospital for the treatment of infectious diseases). Arch, Lond—Nov. 20. 2000 w. 30 cts.

9461. Deep and Difficult Bridge and Building Foundations. George E. Thomas (Extracts from a paper read before the W. Soc. of Engs. Briefly refers to difficult work accomplished by caissons, the freezing plan and pile-driving). Am Arch—Nov. 28. 2000 w. 15 cts.

9489. New York's Great Movement for Housing Reform (An account of the project for improving the dwellings of the poor, with illustrations of the noted men who are supporting the movement and plans of the model dwellings). Rev of Rev—Dec. 6500 w. 30 cts.

9553. The Central Armory, Cleveland, O. (General description, elevations, longitudinal section, transverse sections, features of construction, plumbing, heating and ventilating are given in part first). Eng Rec—Dec. 5. Serial. 1st part. 1100 w. 15 cts.

9607. The Central Penitentiary for the Province of Posen in Wronke. (Das Centralgefangniss fur die Provinz Posen.) (Details of plans with many diagrammatical illustrations). Zeitschrift fur Bauwesen. No. X-XII. 2700 w.

9626. Statics of Structures—Theoretical and Applied. O. F. Semsch (An investigation of the conditions under which the forces acting upon any body will be in equilibrium. Part first treats of the simple beam with uniform load). Am Arch—Dec. 5. 2000 w. 15 cts.

9627. The Planning and Construction of High Office Buildings. William H. Birkmire (Part first discusses the transformation in building construction methods, the cause of the development, with general introductory remarks and many illustrations). Arch & Build—Dec. 5. Serial. 1st part. 1500 w. 15 cts.

9638. Cathedral at Granada and Its Architect (Die Kathedrale von Granada und ihr Baumeister). Carl Justi (One of the largest and best constructed churches of the 15th century). Zeitschr. fur Christi Kunst. No. 7 and 8. 1896. 6000 w.

HEATING AND VENTILATION.

9318. Heating and Ventilation of the Buffalo Real Estate Exchange (Illustrated description of apparatus designed in connection with the designing of the building, and which is a decidedly great improvement on the usual custom). Heat & Ven—Nov. 15. 2500 w. 15 cts.

9319. Friction of Water in Hot Water Heating Pipes. J. H. Kinealy (Investigations which the writer has made in order to fix upon the proper formulae to be used in determining the friction in the pipes of hot water heating systems). Heat & Ven—Nov. 15. 700 w. 15 cts.

9381. Heating and Ventilation. Warren C. Weatherly (General discussion of subject). San Plumb—Nov. 15. 2000 w. 15 cts.

9554. Heating of a Prison Mess Hall and Hospital (Brief illustrated description of building added at Sing Sing prison). Eng Rec—Dec. 5. 300 w. 15 cts.

9605. Heating and Ventilation in the New Reichstag Building at Berlin. (Die Heizung and Luftung im neuen Reichstaggebaude.) (Statement of the requirements, and details of the final installation). Weiner Bauindustrie Zeitung. Oct. 29, 1896. 1800 w.

LANDSCAPE GARDENING.

9477. Parks and Roads. J. F. Foster (Discusses the requirements of an attractive park, the construction, preparation of the ground, designing of necessary structures, construction of walks and roads, &c.). Jour of W Soc of Engs. Oct. 8000 w. 45 cts.

9478. Parks and Park Roads. H. C. Alexander (The most important salient points are discussed, confined mostly to Lincoln Park, Chicago. Followed by discussion). Jour of W Soc of Engs. Oct. 6000 w. 45 cts.

9524. Botanic Gardens. D. T. Macdougal (Treats of the origin and general organization, with illustrations). Pop Sci M. Dec. 4000 w. 45 cts.

9580. Garden Design. F. Inigo Thomas (Read before the British Arch. Assn. Historical review of the treatment of the garden and its relation to architecture, with description of effective sites and the principles of development of garden design. Followed by discussion). Builder—Nov. 28. 9500 w. 30 cts.

PLUMBING AND GASFITTING.

9191. Proper Care of Plumbing Apparatus (Rules prepared by the Plumbing Inspector and Engineer of an American city, for the purpose of showing the citizens the necessity of proper care and management of plumbing apparatus). Plumb & Dec—Nov. 2. 1100 w. 30 cts.

9192. Improved Methods of Drainage Construction. E. C. Lynde (Explains best methods of making socket joints, drain traps and the construction of branch drains, tools required, &c.). Plumb & Dec—Nov. 2. 2000 w. 30 cts.

9243. Plumbing Simplified. William Paul Gerhard (Drawings illustrating a simplified method are given, with discussion of the subject). Arch & Build—Nov. 14. 1800 w. 15 cts.

9279. Some experiments in Interior Illumination. Carter J. Page, Jr. (Read before the Am. Gas Lgt Assn. Investigations of the difference between the loss in candle power of a source of light with and without globes of various densities. Also discussion). Am. Gas Lgt Jour. Nov. 16. 6000 w. 15 cts.

9287. Sanitary Plumbing. Albert E. Hyde (Written for the American edition of the Encyclopedia Britannica. Its relation to the health of the people, with a discussion of house drainage and ventilation of pipes, house water supply and fixtures). Dom Engng. Nov. 1800 w. 30 cts.

9288. German Plumbing. Robert Grimshaw (How plumbing is done in Germany. Information from personal observation and interviews, text books and illustrated catalogues of dealers). Dom. Engng. Nov. Serial. 1st part. 1500 w. 30 cts.

9382. Laying Water Mains. J. H. Decker (Common sense remarks on the various branches of the subject.) San Plumb—Nov. 15. 2000 w. 15 cts.

9485. Material and Tools for Main and Service Laying. E. H. Millard (Read before the England Gas Managers' Assn. Gives experience and results in the practice of the writer; describes and illustrates by diagrams some appliances found useful). Pro Age—Dec. 1. 2500 w. 15 cts.

9630. Service Pipes and Service Piping. T. Littlehales. Coating Service Pipes. A. C. Humphreys (Two short papers read at the meeting of Am. Gas Light Assn. with discussion and illustrations). Am Gas-Light Jour—Dec. 7. 3800 w. 15 cts.

MISCELLANY.

9158. Fire-Proof Construction and Recent Tests. Ill. A. L. A. Himmelwright (Describing the tests of fire-proof qualities lately made by the New York Department of Buildings). Eng Mag—Dec. 3900 w. 30 cts.

9380. Architecture in the University. S. H. Capper (Lecture to the students of McGill University, Montreal. Its right to a place in the curriculum; the general topic of art; the scope of architecture, &c.). Can Arch & Build—Nov. 6000 w. 30 cts.

9400. Prof. Aitchison's Address Before the Royal Institute of British Architects (Defines the position of architecture and reviews the various great epochs of the art, showing what should be considered the duty of architects). Jour Roy Inst of Brit Arch—Nov. 5. 9500 w. 45 cts.

9415. High Buildings and Safe Elevators (An editorial discussion of the recent accident in the American Tract Society

Building, and its importance to those interested in high buildings and their construction). Eng News—Nov. 26. 2500 w. 15 cts.

9419. Rustless Coatings for Iron and Steel. M. P. Wood (Causes of corrosion and protection needed; the danger threatening high buildings of metallic construction, bridges, &c. Examples of remarkable character). Am Soc of Mech Engs—Dec. 3300 w. 45 cts.

9434. Report of Progress of the Committee on Fireproofing Tests (Illustrated report of progress made by a joint committee to the several bodies which created these committees). Am Soc of Mech Engs—Dec. 2000 w. 45 cts.

9435. The Mechanical Plant, Horticultural Hall, Philadelphia (A description, with floor plans, giving special attention to the heating, ventilation and lighting arrangements). Eng Rec—Nov. 28. 2300 w. 15 cts.

9446. Some Experiences of Modern Fireproofing Material in Actual Tests. Peter B. Wight (It is the purpose of the article to give descriptions of incipient fires in fireproof buildings of the best class, with reliable data). Br Build—Nov. Serial. 1st part. 1800 w. 30 cts.

9449. Iffley Church (Information obtained by the Oxford Architectural and Historical Society on a recent visit. Deals more with the history than the architecture). Arch, Lond—Nov. 20. 2400 w. 30 cts.

9476. Notes on Bedford Stone, Louisville Cement and Other Things (A symposium of information gathered on an excursion to these industries, followed by dission. Illustrations). Jour of W Soc of Engs—Oct. 1650 w. 45 cts.

9525. Animal Symbolism in Ecclesiastical Architecture. Andrew D. White (A very interesting review of book by E. P. Evans on this subject). Pop Sci M—Dec. 3800 w. 45 cts.

9541. Against High Buildings (Regarding proposed legislation on the subject, with expressions of opinions from several insurance and real estate men). Fire and Water—Dec. 5. 1400 w. 15 cts.

9559. High Buildings and Safe Elevators (Portions of letters to the editor called forth by the recent editorial on this subject). Eng News. Dec. 3. 2200 w. 15 cts.

9579. Architecture of Italy in the Dark Ages (Illustrated review of the English version of Raffaele Cattaneo's "Architecture in Italy from the Sixth to the Eleventh Century"). Builder—Nov. 28. 4300 w. 30 cts.

9581. An Ideal Architect. Archibald Dunn (Address delivered before the Northern Arch. Assn. The writer's conception of an ideal architect, considering what he must be and know). Arch, Lond—Nov. 27. 2700 w. 30 cts.

9582. The Frescoes of the Sixtine Chapel. W. B. Richmond (Lectures delivered at the Alexandra College, Dublin. Gives a biographical sketch of the painter, Michael Angelo Buonarotti; describes the construction, and pictures). Arch, Lond—Nov. 27. 4000 w. 30 cts.

9602. Action of Refrigerating Plant of the Slaughter-House in Cologne (Die Leistung der Kuhlanlage des stadtischen schlachthofes zu Koln). R. Schlottler (Description of the plant with methods used). Zeitschrift des Vereines Deutscher Ingenieure. Oct. 10, 1896. 3500 w.

9606. Testing Instrument for Foundations (Fundamentprufer) (An instrument devised by Rudolph Mayer. By means of a spring the pressure which will counteract the ground at any point is determined. Wiener Bauindustrie Zeitung. Oct. 22, 1896. 1400 w.

9608. The Decoration in Paris During the Franco-Russian Festivities (La Decoration de Paris pendant les fetes Franco-Russes) (Short description of the principal decorations of the public buildings during that time). L'Architecture. Oct. 10, 1896. 700 w.

CIVIL ENGINEERING.

BRIDGES.

9187. A Concrete Arch Bridge of Forty Feet Span (Illustrated description of concrete highway bridge of forty feet span built across Richmond Creek, Belleville, Ill.). Sci Am Sup—Nov. 14. 600 w. 15 cts.

9397. Counterweighted Lift Bridge on the Erie Railroad (Description with perspective view of bridge across Berry's Creek, near Rutherford, N. J.). Sci Am—Nov. 28. 600 w. 15 cts.

9412. A Novel Lift Bridge on the Erie (Illustrated detailed description of the bridge over Berry's Creek, about seven miles from Jersey City). R R Gaz—Nov. 27. 2500 w. 15 cts.

9482. Bridge Practice (Discusses whether it is permissible in good practice to erect structures in which it is impossible to estimate, after a year's working, the maximum strains in the different bars). Engng—Nov. 20. 1300 w. 30 cts.

9557. The Accuracy of the Ordinary Formulas for Swing Bridges. F. E. Turneaure (The discussion considers truss bridges only, and examines the formulas for continuous girder with constant moment of inertia, pointing out an easy method for determining the degree of approximation in any given case, and of correcting the computations if desired). Eng News—Dec. 3. 2300 w. 15 cts.

9571. Replacing a Main Line Railway Bridge in 150 Minutes (Illustrated description of a remarkable piece of bridge-building and removal on the Great Northern Railway at Peterborough). Eng, Lond—Nov. 27. 1800 w. 30 cts.

9595. The Operating Mechanism of the New Rock Island Bridge (Describes the swinging machinery proper, rail locks, the end jacks, interlocking and controlling systems and controlling device). Am Eng & R R Jour—Dec. 1300 w. 30 cts.

9609. The Iron Bridge Over the Otterthal (Die eiserne Thalbrucke uber des Otterthal) (Ernst Biedermann, of Berlin, gives detailed description of this bridge, which is built on the American type of scaffolding bridges, a method especially applicable in this particular instance). Zeitschrift fur Bauwesen. No. X-XII. 4900 w.

9615. The Kornhaus Bridge in Berne (Die Kornhaus bruke in Bern). By H. V. Linden (All the details of this bridge, from the development of the project to its final construction are presented. The bridge is supported by an arch across the river and built on the ordinary girder plan on land). Schweizerischke Bauzeitung. Oct. 17, 1896. Serial. 1st part. 6300 w.

CANALS, RIVERS AND HARBORS.

9246. Deepening the Thames (From the London Times. Describes an improvement that will affect the navigable channels of the river between Gravesend and the Nore). Arch, Lond—Nov. 6. 1200 w. 30 cts.

9323. A Survey of a Great Lakes and Hudson River Ship Canal (A presentation of the principal facts and a discussion of the results, as based on data from report by Albert J. Heines. No great accuracy is claimed for the estimater. The editor's views regarding the construction of a ship canal from the Great Lakes to the Atlantic Ocean are given briefly). Eng News—Nov. 19. 1800 w. 15 cts.

9384. New York Harbor and Trade (Editorial comment on the improvements needed in the harbor and the amount of trade passing this port, with the need of effort to keep it from drifting to other seaports). Trans—Nov. 13. 1600 w. 30 cts.

9545. The Improvement of the Channel of the Delaware River. Walter Atlee (Illustrated description of improvements already made. Followed by discussion). Jour Fr Inst—Dec. 11000 w. 45 cts.

IRRIGATION.

9301. The Irrigation of Arid Lands. J. J. Miller (Deals with the artificial means of making arid lands profitable). Yale Sci M—Nov. 2000 w. 30 cts.

9398. Possibilities of Irrigation in Montana. S. B. Robbins (Claims 20,000,000 acres of arable land in the State which could be profitably irrigated. Reviews the advantages and the conditions). W Min Wld—Nov. 21. 2000 w. 15 cts.

9497. A Problem of Aridity. C. M. Harger (The situation in the West, decrease in value of property and serious conditions to be met by the people of the semi-arid regions). N Am Rev—Dec. 1700 w. 45 cts.

9555. The Mt. Nebo Reservoir and Canal System, Utah. W. P. Hardesty (Illustrated description of the construction work). Eng News—Dec. 3. 3000 w. 15 cts.

9558. The Ownership and Control of Water in the Irrigated West (Discusses some of the broader phases which are intimately connected with the character of irrigation works). Eng News—Dec. 3. 2000 w. 15 cts.

9560. The Measurement of Water for Irrigation. J. B. Pope (An attempt to demonstrate the importance of abolishing the "miner's inch" and adopting cubic feet per second as a unit of measurement for all water systems. Tables, carefully calculated and their correctness demonstrated, are given with explanations). Eng News—Dec. 3, 3500 w. 15 cts.

MISCELLANY.

9209. Presidential Address of J. Wolfe Barry before the Institution of Civil Engineers, London (An interesting retrospective survey of the general progress with which engineering is intimately connected, especially during Queen Victoria's reign, with other subjects of interest). Eng, Lond—Nov. 6. Serial. 1st part. 6000 w. 30 cts.

9211. The Effect of Admixtures of Kentish Ragstone, &c., upon Portland Cement. D. B. Butler (Abstract of paper read before the Soc. of Engs., London. Illustrated description of experiments by the writer, with results and conclusions). Eng, Lond —Nov. 6. 2800 w. 30 cts.

9309. Rocks Suitable for Road-Making. U. S. Shaler (Brief discussion of varieties and their fitness and unfitness for road-making). Stone—Nov. 700 w. 30 cts.

9324. The Application of Photography to Surveying (Abstract from a paper by John S. Dennis, of Ottawa, Can., read before the Denver meeting of the Am. Soc. of Irrigation Engs. The principle of the method). Eng News—Nov. 19. 1000 w. 15 cts.

9333. The New Shore Road in Brooklyn, N. Y. (An account of a proposed drive which when completed promises to be one of the most attractive in the world). Eng Rec—Nov 21. 1000 w. 15 cts.

9404. The Proper Profile for Resisting Wave Action. Robert Fletcher (Abstract of a paper filed in the library of this society. A continuation of previous study of the subject by the writer). Am Soc of Civ Engs—Nov. 2800 w. $1.

9499. Development of the American Portland Cement Industry. Frederick H. Lewis (Considers the conditions which prevail in manufacturing, in using, and in testing cements in this country, and discusses the course which it is advisable to follow in dealing with cements). Munic Engng—Dec. Serial. 1st part. 1100 w. 30 cts.

9500. Forms of Clip and Briquet for Tensile Tests of Cement. L. C. Sabin (The form of briquet recommended by the committee of the Am. Soc. of Civ. Engs. was used in the tests described, with various styles of clips) Munic Engng—Dec. Serial. 1st part. 1400 w. 30 cts.

9556. The Sinking of a Wharf at St. John, N. B. (Account taken from the Daily Sun and Daily Telegraph, of St. John, N. B.). Eng. News—Dec. 3. 1300 w. 15 cts.

9569. Practice with Science (Abstract of a Presidential address delivered by Mr. Henry McLaren before the Yorkshire College Engineering Society. Chap. I. deals with the practical man; Chap. II. with the scientific man, and Chap. III. with the man who combines practice with science). Engng—Nov. 27. 6000 w. 30 cts.

ELECTRICITY.

ELECTRO-CHEMISTRY AND METALLURGY.

9170. On the Specific Gravity and Electrical Conductivity of the Normal Solutions of Sodium and Potassium Hydroxides and Hydrochloric, Sulphuric, Nitric and Oxalic Acids. E. H. Loomis (A measure of the specific gravity and electrical conductivity of various solutions whose preparations are described). Phys Rev—Nov.-Dec. 900 w. 45 cts.

9257. Electricity as Applied to Metallurgy. Prof. Threlfall (Brief history, both theoretical and practical). Aust Min Stand—Sept. 6500 w. 30 cts.

9493. Electricity in Gold Milling. H. M. Chance (A classification of the numerous methods by which it has been proposed to use electricity for this purpose. Followed by discussion). Pro Engs' Club of Phila—Nov. 2500 w. 45 cts.

9514. The Action in the Jacques Carbon Cell. C. J. Reed (Comment on the theories advanced). Elec Eng—Dec. 2. 1000 w.

9601. Method for Electrolytically Desilverizing Lead (Procede de Desargentation electrolytique des plombs argentiferes). By D. Tommasi (Value of constructing a factory for the purpose and the principle on which the process is based). L'Eclairage Electrique. Oct. 17, 1896. Serial. 1st part. 4200 w.

LIGHTING.

9157. Are Electric Central Stations Doomed? Max Osterberg (Showing how isolated plants may be economical in electric-lighting). Eng Mag—Dec. 1900 w. 30 cts.

9178. Studies in the Spectrum of Reflection. Dr. W. H. Birchmore (This paper is intended to make clear some obscure points in a previous article published in this paper Sept. 30). Elec Eng—Nov. 11. 1300 w. 15 cts.

9200. Electric-Lighting at the People's Palace (Illustrated description of the plant). Elec, Lond—Oct. 23. 2400 w. 30 cts.

9210. The Electric-Lighting of the Theatre of Earl's Court Exhibition (Illustrated description of the arrangement of the lights). Eng, Lond—Nov 6. 1000 w. 30 cts.

9219. The Electric-Lighting of Croydon (Brief illustrated description). Elec Rev, Lond—Nov. 6. 2800 w. 30 cts.

9244. Bury Electricity Works (Illustrated detailed description). Elec Eng, Lond—Nov. 6. 3000 w. 30 cts.

9245. Electrical Installations. F. J. Warden-Stevens (The author's aim is to place before architects and others information which will prove a source of help when having such matters under consideration. Part first is devoted largely to motive power). Arch, Lond—Nov. 6. Serial. 1st part. 2800 w. 30 cts.

9297. Isolated Lighting and Power Plant at Hearst Haciende, Sunol, Cal. (Illustrated description). Am Electn—Nov. 700 w. 15 cts.

9298. Lighting of a Country Residence. E. G. Bernard (Illustrated description of a simple system for residence lighting). Am Elect'n—Nov. 1000 w. 15 cts.

9299. Typical Electric Plant for Country Residences. Maurice Barnett (The writer aims to show that electric lighting can be carried on economically in the country, and light be had at any hour of the day or night without the necessity of running the engine more than a few hours three or four times a week, except when the full capacity of the dynamo is wanted nightly). Am Electn—Nov. 1600 w. 15 cts.

9316. The Carbon Circuit of an Incandescent Lamp. Converse D. Marsh (Discussion, with illustrations of the neglected features which injure the efficiency of lamps. Elec. World—Nov. 21, 900 w. 15 cts.

9317. Tower Wagon for Arc Lamp Trimmers. (Illustrated description). W. Elec—Nov. 21. 600 w. 15 cts.

9351. Leyton Electric Lighting. (Illustrated description of a gas driven installation). Eng, Lond—Nov. 13. 1800 w. 30 cts.

9356. The Development of the Arc Lamp. J. Warren (The writer proposes to describe details of principle and construction in the matter of arc lamps, from the time of their first practical utilization to the present day). Elec, Lond—Oct. 30. Serial, 1st part. 2300 w. 30 cts.

9367. The Hastings Electric Light System (Illustrated description with details of unusual features). Elect'n—Nov. 13. 3500 w. 30 cts.

9383. Manchester Ship Canal Electricity Works (Brief illustrated description of the lighting of the docks). Elec Rev, Lond—Nov. 13. 1800 w. 30 cts.

9392. The New Station of the Southern Electric Light and Power Co., Philadelphia, Pa. (Illustrated description of a complete and extensive plant). Elec Eng—Nov. 25. 900 w. 15 cts.

9408. The Determination of the Quality of a Vacuum by Electrostatic Discharge. Converse D. Marsh (An account of tests of lamps on the American market made under the direction of the writer to determine the quality of the vacuum). Elec Wld—Nov. 28. 1400 w. 15 cts.

9487. Electric Lighting in Cape Town (From report of A. P. Trotter. The work seems to be very inferior and unsatisfactory). Eng, Lond—Nov. 20. 2500 w. 30 cts.

9509. Electric Lighting at Darwen. Report of E. M. Lacey (Gives the probable demand for current, the most suitable system, capital outlay necessary, probable profit, the desirability of combining the electricity works with a system of refuse destructors). Elec Eng, Lond—Nov. 20. 3500 w. 30 cts.

9563. New Physical Phenomena of Roentgen Rays. Charles Lester Leonard (Extract from a paper read before the Am. Phil. Soc. New phenomenon observed with experiments and conclusions). Elec World—Dec. 5. 1200 w. 15 cts.

POWER.

9183. Negative Efficiency. F. A. Halsey (Showing that the possible range of efficiency in machines must be set down to be from minus infinity to plus one). Am. Mach—Nov. 12. 1000 w. 15 cts.

9268. The Siemens & Halske Electric Company of America (Illustrated description). Elec Wld—Nov. 14. Serial, 1st part. 1600 w. 15 cts.

9302. Niagara Falls Power in Buffalo. Stephen L. Coles (An illustrated account of the successful test made at midnight Nov. 15. Brief description of the transmission line and its construction). Elec Rev—Nov. 18. 3000 w. 15 cts.

9313. Niagara Power Transmission Up to Date. Frank C. Perkins (Part first is an illustrated description of the electrical equipment for the Buffalo Street Railway). Elec Wld—Nov. 21 Serial, 1st part. 1200 w. 15 cts.

9314. Synchronous Motor as Compensator in Alternating-Current Distributions. Ernst J. Berg (The article will show how the losses and the compounding of the generator are affected by using a synchronous motor as compensator in an alternating-current system, discuss the general effect of synchronous motors at various power factors of the load, and the most suitable size of synchronous motor to be used and the gain made thereby). Elec Wld—Nov. 21. Serial, 1st part. 2000 w. 15 cts.

9365. Boosting with Alternating Currents. Alexander Russell (Boosting is briefly described, the theory considered and illustrations given). Elect'n—Nov 13. 1300 w. 30 cts.

9396. Volts vs. Ohms. H. Ward Leonard (Paper presented at meeting of Am. Inst. of Elec. Engs. Speed regulation of electric motors). Elec—Nov. 25. 2800 w. 15 cts.

9451. The Economies of Electric Power Plant. C. C. Longridge (Instances of power economy effected by the use of electricity, calling attention to the mechanical principles on which the economy is based). Min Jour—Nov. 21. 1300 w 30 cts.

9490. The Electric Storage Battery. Rudolph H. Klauder (Calls attention to the dawning of a new era in electrical station practice in this country. The advantages of accumulators are considered, the situation in this country and in Europe is explained, the practical uses that can be made of the storage battery in generating plants, cost, &c.). Pro Engs' Club of Phila—Nov. 10000 w. 45 cts.

9536. Old Hydraulic Canal Plant at Niagara Falls Transformed for Electrical Transmisssion. Orrin E. Dunlap (Illustrated description of the changes made). W Elec—Dec. 5. 2000 w. 15 cts.

9565. Calculation of Electrical Motors. Alfred E. Wiener (Part first deals with finding the capacity of a generator corresponding to a motor of a given output, and speed calculations of electrical motors). Elec Wld—Dec. 5. 1500 w. 15 cts.

9597. Rotary Transformer. (Transformateur rotatif.) Saturnin Hanappe. (Description of 5 k. w. direct current transformer.) L'Leclairage Electrique—Oct. 17, 1896. 1400 w.

9598. Electromotive Force Produced in a Portion of a Gramme Ring, Moving in a Constant Magnetic Field. (Determination de la force electromotive induite dans une portion d'anneau Gramme tournant dans un champ magnetique uniforme.) By Loppe. (Derivation of formulae.) L'Eclairage Electrique—Oct. 17, 1896. 800 w.

9599. Electric Power in Shops. (Les transmissions electriques dans les ateliers.) A. Hillairet (Registering instruments employed to indicate power used by motors driving saws, drills, planers, &c.). L'Eclairage Electrique—Oct. 17, Nov. 7, 1896. Serial. 1st part. 2100 w.

9600. New Method for Determining Dynamo Efficiency. (Nouvelle Methode pour la Determination des Rendements.) J. L. Rontin. (The Measurements are made with a tachometer only.) L'Eclairage Electrique—Oct. 24, 1896. 1200 w.

9604. Alternating Current Machinery of Ganz & Cie. A. O. Dubsky and P. Girault. (Le Material a courants alternatifs.) (Description of the principal types manufactured by that firm). 1000 w.

9612. Automatic Starting and Stopping Devices for Electric Elevator Service. (Selbstthatige Anlass-und Abstellvorrichtungen fur elektrischen Fahstuhlbetrieb). G. Speiser. (German types and detailed methods of construction). Elektrotechnische Zeitschrift—Oct. 15, 1896. 1000 w.

9613. Electric Power Plant at the Berlin Exposition. (Elektrische Starkstromanlagen auf der Berliner Gewerbeansstellung). Ludwig Mittelmann. (Details of all power and lighting machinery furnished by the different manufacturers). Elektrotechnische Zeitschrift — Oct. 15, 1896. Serial. 1st part 900 w.

9614. Measurement of Earth Resistance in Power Circuits by Means of Line Potential. (Die Messung des Erdwiderstandes von Starkstromanlagen mittels der Betriebsspannung). Dr. Oscar May. (Accompanied by a table of energy losses due to leakage). Elektrotechnische Zeitschrift —Oct. 22, 1896.

9628. On Drehstrom Motors with Reduced Speeds. Hans Gorges in Elek. Zeitsch (Describes a new and interesting phenomenon, which the writer considers only a special case of a much more general group of phenomena, which may have a practical value as well as a theoretical interest). Elec Rev, Lond—Nov. 27. 800 w. 30 cts.

9646. A New Electric Light and Railway Power Station of the Edison Electric Illuminating Co. of Paterson, N. J. (Illustrated, detailed description). Elec Eng—Dec. 9. 4500 w. 15 cts.

TELEPHONY AND TELEGRAPHY.

9175. Underground Telephone Wires in Indianapolis (Illustrated description of the system used). Elec Eng—Nov. 11. 700 w. 15 cts.

9230. Telephone Conduits and Subways. Dr. V. Wietlisbach (Illustrated article treating of simple construction, subways and conduit or duct construction). Elec Engng—Nov. 7000 w. 15 cts.

9266. Insulated Wires and Cables; Their Construction and Design—Insulation; 1st Efficiency and Defects. J. Draper Bishop (These papers are intended to cover broadly the manufacturing processes of all kinds of cables at present used, as well as the principles governing their design and the value of their insulation electrically. Deep-sea telegraph cables, however, are omitted Part first considers the commercial side of the question and describes briefly the physical nature and qualities of the various insulating materials). Elec Wld—Nov. 14 Serial. 1st part, 3000 w. 15 cts.

9267. Telephone Repeaters or Relays and Repeating Systems. Thomas D. Lockwood (Long running comment on newspaper electrical news is followed by the personal views of the writer on the subject given). Elec Wld—Nov. 14. Serial. 1st part. 5500 w. 15 cts.

9296. The Berliner Microphone Patent before the U. S. Supreme Court. (Important arguments, on both sides, with editorial comment). Elec Eng—Nov. 18. 4000 w. 15 cts.

9363.—The Telephone Trunk Line System in Great Britain. J. Gavey (A review of the theoretical principles involved in the erection of balanced telephone circuits). Elec Eng, Lond—Nov. 13. Serial 1st part. 2500 w. 30 cts.

9395. Casual Notes on the Use of Telephone Election Returns. George Heli Guy (The good work done all over the country with curious and amusing features). Elec Eng—Nov. 25. 1400 w. 15 cts.

9445. Improvement in Dynamo-Telegraphy. F. P. Medina (The equipment of the Pacific Postal Telegraph Co. in San Francisco is described in part first, and an improvement by which the dynamo quadruplex is being worked with greater efficiency than was attained with chemical batteries). Elec, Lond—Nov. 13. Serial 1st part. 1500 w. 30 cts.

9513.—Cailho's System of Simultaneous

Telegraphy and Telephony (Description, illustrated by diagrams). Elec Eng—Dec. 2. 800 w. 15 cts.

MISCELLANY.

9168. A Study of the Apparent Capacity of Condensers for Short-Charge Periods. Hubert V. Carpenter (Experiments are described and results discussed). Phys Rev—Nov.-Dec. 1000 w. 45 cts.

9169. Note on the Osmotic Theory of the Voltaic Cell. H. M. Goodwin (A reply to criticism by Mr. Bancroft of results published by the writer). Phys Rev—Nov.-Dec. 1200 w. 45 cts.

9176. Roentgen Ray Apparatus. The Current Interrupter. W. M. Stine (An examination of types of interrupters). Elec Eng—Nov. 11. 1200 w. 15 cts.

9177. Dr. Sheldon on Electrical Measurements of Precision (Synopsis of lecture delivered before the Electrical Department of the Brooklyn Institute. Advance and improvement in methods). Elec Eng—Nov. 11. 700 w. 15 cts.

9179. Mysterious Breakdowns of Insulation. Elihu Thomson (Reference to editorial in issue of Oct. 21 on this subject and calling attention to points that would tend to remove danger). Elec Eng—Nov. 11. 1000 w. 15 cts.

9201. Applications of Electricity. Ellis H. Crapper (Part first is devoted to electrical measurements of high temperatures). Elec, Lond—Oct. 23. Serial. 1st part. 1000 w. 30 cts.

9218. Methods of Charging for Electricity (Illustrated description of the Wright rebate indicated and the ways in which it is used). Elec Rev, Lond—Nov. 6. 2800 w. 30 cts.

9248. Armature Reactions. Alexander Rothert (Abstract of a paper read at the Berlin meeting of the Verband Deutscher Elektrotechniker. A new method for the dimensioning of generators in the use of alternating or polyphase currents, and to account for their mode of action, and especially for the loss of pressure in the cases of inductive and non-inductive loads. Illustrated by diagrams). Elect'n—Nov. 6. 4500 w. 30 cts.

9265. Standard Cells. Henry S. Carhart (An account of a few standard cells which the writer has kept for several years). Elec Wld—Nov. 14. 1100 w. 15 cts.

9312. A Carbon Cell Without a Metal Electrode. C. J. Reed (Objections made to Dr. D. Tommasi's theory of chemical reactions). Elec Wld—Nov. 21. 500 w. 15 cts.

9366. On the Resistance of the Electric Arc. Julius Frith and Charles Rodgers (Communicated to the Phil. Mag. of the Physical Society. Resistance of the arc is defined, and account given of a series of experiments undertaken to determine the resistance of the arc under various conditions). Elect'n—Nov. 13—5000 w. 30 cts.

9391. Electric Sad Irons in a Hospital for the Insane (Illustrated description of the equipment of the Central Indiana Hospital for the Insane, at Indianapolis, Ind.) Elec Rev—Nov. 25. 800 w. 15 cts.

9393. Insulation. W. M. Stine. (The properties of insulating materials; mechanical difficulties; the care necessary in the application and use of insulation). Elec Eng—Nov. 25. 1200 w. 15 cts.

9462. Some Recent Developments in Magnetic Testing. Prof. Ewing. (Describes a special procedure in the ballistic test of bars. The object is to eliminate the error due to the magnetic resistence of the yoke in tests made with bars and yokes. Elect'n—Nov. 20. 1400 w. 30 cts.

9463. The Direct Production of Electrical Energy. Bertram Blount. (Reviews a recent record of experiment by Herr Ernst Andreas in the Zeitschrift fur Elektrocheme, who has been revising and extending the work of Dr. Borchers). Elect'n—Nov. 20. 1300 w. 30 cts.

9464. Roentgen Ray Apparatus (The latest tubes employed for producing esographs are described and other apparatus used in the work). Elec Rev, London—Nov. 20. 2300 w. 30 cts.

9465. Idle Currents. (A study of the problem of worthless currents and means of suppressing them). Elec Rev, London—Nov. 20. 1300 w. 30 cts.

9494. Roentgen Phenomena—Theory and Practice. Elmer G. Willyoung (An examination of the characteristics of the X-rays and what can be done with them). Pro Engs' Club of Phila—Nov. 5500 w. 45 cts.

9515. Tesla on the Roentgen Streams (Illustrations and conclusions from recent study of this subject. Points out possibilities of producing nitrogen compounds, explains causes of effects on the skin, and shows the hopelessness of making the blind see by the use of X-rays). Elec Rev—Dec. 2. 4000 w. 15 cts.

9537. On the Effect of Removing the Ends of a Magnet. Joseph F. Smith (Experiments made to ascertain the effect of cutting from the ends of a wide, thin magnet strips whose width is small compared with their length). W Elec—Dec. 5. 600 w. 15 cts.

9561. On the Mode of Transferring Energy in the Electric Circuit. Edwin J. Houston and A. E. Kenelly (A suggestion of how the transfer may take place, not merely under the general formula of "motion of Faraday tubes of force through space" but concretely by the use of the more fundamental conception of the energy resident in electrostatic flux). Elec Wld—Dec. 5. 1500 w. 15 cts.

9562. Corrosion Caused by Railway Return Currents. Dugald C. Jackson (Detailed results of experiments to determine the differences in the reactions which occur when lead and iron are respectively the metal of the anode upon which the corrosion takes place). Elec Wld—Dec. 5. 800 w. 15 cts.

9564. Some New Electrical Apparatus. Reginald A. Fessenden (Part first describes a new tachometer and a new alternating-current curve tracer, giving illustrations). Elec Wld—Dec. 5. Serial. 1st part, 3300 w. 15 cts.

9647. Interchangeable Electric Signs. Theodore Waters (Illustrated description of electrical effects for advertising purposes, and the newest features in this business). Elec Eng—Dec. 9, 1600 w. 15 cts.

INDUSTRIAL SOCIOLOGY.

COMMERCE AND TRADE.

9153. The cost of Iron as Related to Industrial Enterprises. George H. Hull (Urging the advantages of exchange dealings in pig iron by the warrant system"). Eng Mag—Dec. 2600 w. 30 cts.

9348. Foreign Shipping Subsidies (The effect of subsidies on English commerce). Engng—Nov. 13. 1200 w. 30 cts.

9386. The Tinplate Industry and American Competition (The impossibility of restoring the scale of 1874, because of the changed conditions, and a report of the progress of the industry in America). Ir & Coal Trds Rev—Nov. 13. 1500 w. 30 cts.

9399. Japan; Its Openings and Opportunities (The importance of this trade to Great Britain; the trade of other countries with Japan; industrial progress in that country). Mach, Lond—Nov. 15. 2500 w. 30 cts.

9401. Tariff Changes and Customs Regulations (Russia, Russian Turkestan, Sweden, Germany, France, France-Dahomey, Spain, Phillipine Islands, Italy, United States, Mexico, Nicaragua, Guatemala, Ecuador, Brazil, Argentina, Liberia, British India, British Honduras, New South Wales and Victoria). Bd of Tr Jour—Nov. 7000 w. 30 cts.

9467. India; Its Arts, Manufactures and Commerce (Address of Sir Owen Tudor Burne, before the Soc. of Arts. Reviews the natural features of the country in order to show the difficulties experienced by those who have had to deal with the arts, manufactures and commerce of the country; notes its natural products; the effect of the arts on the people and gives much interesting information). Jour Soc of Arts—Nov. 20. 6000 w. 30 cts.

9498. Our Trade with South America. Theodore C. Search (Discusses the movement of the United States to secure a large share of the trade of the outer world, especially in South America; considers the conditions and possibilities of this trade, and indicates the general lines for the extension of export trade). N Am Rev—Dec. 2800 w. 45 cts.

9526. Hides and Leather in Europe (Responses from American Consuls in various countries to a circular letter sent by the Dept. of State desiring them to obtain information regarding this industry and how to increase the same in the consular district). Cons Repts—Nov., 1896. 23500 w. 45 cts.

9570. Modern Japan—Industrial and Scientific (A discussion of Anglo-Japanese business relations is given in part first. Also an abstract of the treaty of commerce and navigation between Japan and Great Britain). Eng., Lond—Nov. 27. 3500 w. 30 cts.

9639. The India Rubber Industry in Europe (Statistics relating to the quantity and value of crude India-rubber imported by Russia and the export of manufactures. Also information concerning the trade conditions of this product in Germany). Ind Rub Wld—Dec. 10. 900 w. 35 cts.

9640. The Demand for Rubber Goods in the Amazon. M. F. Sesselberg (Suggestions for increasing trade with some comment on the quality of goods best suited to the people, and on other articles of import). Ind Rub Wld—Dec. 10. 1200 w. 35 cts.

9641. An English View of German Trade Rivalry (Discusses the causes of the falling of England's commerce and industry. Statements from book by Ernest Edwin Williams and from Consular Repts. Remedies suggested). Cons Repts—Dec. 2000 w. 45 cts.

CURRENCY AND FINANCE.

9156. Examination of Corporation Accounts by Auditors. Thomas L Greene

(Showing the functional incapacity of the auditor, as such, to pass upon a corporation's solvency). Eng Mag—Dec. 3300 w. 30 cts.

9642. The Future of Gold. Alex. Del Mar (Discusses free coinage in relation to mining and metallurgy. The eras of gold production are defined and seigniorage is recommended). Gunton's Mag—Dec. 2200 w. 30 cts.

GOVERNMENTAL CONTROL.

9173. Methods of Determining the Economic Productivity of Municipal Enterprises. Walter F. Willcox (Read before the Am. Social Science Assn. The discussion of the subject is limited to the class of enterprises which aim at rendering an economic service). Am Jour of Soc—Nov. 4500 w. 45 cts.

9205. Honesty in the Management of Corporations (Editorial showing the necessity of corporations, comparison of public and private corporations, the temptations to make gains and the protection given by publicity in contracts). Eng. News—Nov. 12. 1800 w. 15 cts.

LABOR.

9150. Labor Riots and So-Called "Government by Injunction." Leonard E. Curtis (Showing that the courts did not exceed their prerogative, or over-estimate the exigency of the occasion, in using their power of injunction to suppress the Chicago riots of 1894). Eng Mag—Dec. 6800 w. 30 cts.

9171. The Working Boy. Florence Kelley (A discussion of the needs to be kept in view in technical education, because of the industrial instability of the times. Changes brought about by recent inventions are discussed). Am Jour of Soc—Nov. 4500 w. 45 cts.

9233. Arbitration in Labor Disputes. Mr. and Mrs. Sidney Webb (The essential features and characteristics of arbitration, the disadvantages from the views of employers and employed, the work of conciliation and the conclusions to be drawn from analysis of the subject). Nineteenth Cent—Nov. 6500 w. 45 cts.

9474. The Strikes and Lock-Outs of 1895 (Extracts from report of Mr. Burnett of the Labor Dept. of the Bd. of Trade. Shows a material diminution as compared with previous years). Col Guard—Nov. 20. 1500 w. 30 cts.

9510. The Leadville Strike (An article endeavoring to set forth the true causes of the trouble). Min Ind & Rev—Nov. 26. 1300 w. 15 cts.

9645. Labor Insurance in Germany (Shows the changed conditions which make provision for maintenance of the wage-earner during disability and old age necessary, and recommends a comprehensive plan of labor insurance). Gunton's Mag—Dec. 1500 w. 30 cts.

MISCELLANY.

9172. Immigration and Crime. Hastings H. Hart. (The writer objects to an article by Mr. F. W. Hewes, in the Outlook of March 7, 1896, claiming that the conclusions are misleading. He gives a different method of comparison and the results, which he claims can be established.) Am Jour of Soc—Nov. 2000 w. 45 cts.

9232. Commercial Morality in Japan. Robert Young. (A discussion of facts which illustrate the standard of commercial morality, and show the effect upon trade.) Nineteenth Cent—Nov. 3800 w. 45 cts.

9421. A Method of Determining Selling Price. H. M. Lane. (A method is proposed by which the conditions affecting the final result of a year's business may be shown in a simple manner at the end of each month or week.) Am Soc of Mech Engs—Dec. 1700 w. 45 cts.

9441. The Industrial Revolution in Japan (From the report of Mr. W. E. Curtis, as published in the Dept. of Labor of the United States. Showing that Japan is becoming less and less dependent upon foreign nations; recent industrial developments, and facts affecting the industries.) Ind & East Eng—Oct. 24. 2200 w. 45 cts.

9456. An Unfeigned Issue. George Bryan. (The writer proposes to give in popular language a synopsis of four judicial decisions affecting the industries of the country, with a few general deductions.) Am Mag of Civ. Nov. 5800 w. 30 cts.

9457. The Fundamental Reform. W. H. T. Wakefield. (The writer claims the criminals, tramps, paupers, &c., are the result of an economic policy which encourages monopolies and discourages industry. The fundamental reform as stated by him is access to nature's bounties upon equal terms for all.) Am Mag of Civ—Nov. 1000 w. 30 cts.

9496. Penal Colonies, Agricultural and Industrial. Arthur Griffiths (Discusses the various penal systems already tried and shows their weaknesses; pronounces the penal colony the best solution of the problem and describes the lines on which it should be planned and governed). N. Am Rev. Dec. 4400 w. 45 cts.

9548. The Modern Version of the Law of Supply and Demand. R. H. Thurston (A discussion of the relations between wages, prices, costs and quantity). Science —Dec. 4. 800 w. 15 cts.

9643. Common Sense in Trusts (Evidences of a true economic view gradually coming to be recognized. A discussion favorable to trusts). Gunton's Mag—Dec. 1800 w. 30 cts.

9644. Statistics of Immigration (Tables giving results of investigation, with representative facts and their social significance). Gunton's Mag—Dec. 1000 w. 30 cts.

MARINE ENGINEERING.

BOILERS AND ENGINES.

9237. Marine Boilers, Particularly in Reference to Efficiency of Combustion and Higher Steam Pressures. J. R. Fothergill (Read before the Northeast Coast Inst. of Engineers and Shipbuilders, in Cardiff. A discussion of the needs and difficulties, and the demand for increased pressure, with the objections, and general discussion of the subject). Jour Am Soc of Naval Engs—Nov. 3800 w. $1.25.

9340. Testing Steel for Marine Engine Construction. From Inst. of Civ. Engs., Foreign Abstract. (An account of the tests made at the French Government Engine Works, at Indret.) Eng—Nov. 21. 1200 w. 15 cts.

9586. Twisting Moments of Quadruple Expansion Engines. H. J. Teiper (Results and method of obtaining the twisting moments or crank effort as worked out by the writer, with necessary explanations). Eng —Dec. 5. 1500 w. 15 cts.

NAVAL AFFAIRS.

9236. Contract Trial of U. S. Armored Cruiser Brooklyn. W. C. Herbert (Illustrated detailed description of the vessel, with data of trial). Jour Am Soc of Naval Engs—Nov. 6500 w. $1.25.

9307. The Coast Defense Monitor Amphitrite (Illustrated description). Sci Am —Nov. 21. 1300 w. 15 cts.

9330. The New Battleship. Philip Hichborn (Abstract of a paper read before the Soc. of Naval Archts. and Marine Engs. Description of the special features of the Alabama class, the most recently designed battleships of the U. S. Navy, with a tabular statement of the general particulars of the designs). R R Gaz—Nov. 20. 1600 w. 15 cts.

9341. Triple Screw Vessels (Opinion of Prof. Carl Busley, German Navy, in his paper on "Our Fleet," Zeitschrift des Vereines Deutscher Ingenieure). Eng.—Nov. 21. 1000 w. 15 cts.

9350. The Navies of the World (A summary of the fleets of Great Britain, France and Russia, with comments). Eng, Lond —Nov. 13. 2000 w. 30 cts.

9416. Naval Practice in Ship Rivets and Riveting. J. H. Linnard (Read at meeting of the Soc. of Naval Archts. and Marine Engs. Rules for riveting are given in tabular form, the great importance of the subject shown, and general information given). Eng News—Nov. 26. 2400 w. 15 cts.

9495. The Engineer in Naval Warfare. John G. Walker, A. T. Mahan, R. D. Evans and S. A. Staunton (A symposium of opinions on the standing of engineers in the navy). N Am Rev—Dec. 9500 w. 45 cts.

MISCELLANY.

9189. Ship and Stokehold Ventilation (Illustrated description of apparatus patented by Messrs. Evans, Harris & Evans, of Manchester. It is called the "Anemogene" system, and is deserving of the attention of ship owners). Steamship—Nov. 500 w. 30 cts.

9190. Remarks on Sail and Steam Power Combined. H. C. Vogt (A paper designed to show that a special construction of sails is necessary to work efficiently along with steam power, and that sails and steam power, properly constructed, act to the best advantage when used together). Steamship—Nov. 1500 w. 30 cts.

9272. Twin-Screw Steamer Pennsylvania (An illustrated description of the largest steamer afloat). Am Shipbuilder —Nov. 12. 1100 w. 15 cts.

9283. The Atlantic Greyhound of the Future. J. H. Biles, in Cassell's Family Magazine (A review of the increase in speed and a prophecy for the future). Safety V—Nov. 900 w. 15 cts.

9300. Ship Building on the Clyde. Francis S. North (A brief review of the changes brought about in this region, with description of the plant of the Fairfield Company). Yale Sci M—Nov. 1900 w. 30 cts.

9325. Steel Canal Boats. Lewis Nixon (Condensed from a paper read before the Soc of Naval Archts and Marine Eng. Describes the boats and gives midship cross-section drawings. The paper is devoted largely to an argument on the economy of running boats through from lake ports to New York). Eng News. Nov. 19. 2000 w. 15 cts.

9326. Speed Trials of a Screw Propelled Ferry Boat. F. L. Du Bosque (Trials made with the screw-propelled ferry boat Cincinnati are described). Eng News—Nov. 19. 1700 w.

9343. Commissioner of Navigation

Chamberlain's Last Annual Report (Editorial review of the report, with criticisms). Sea—Nov. 19. 6500 w. 15 cts.

9448. About the "Ernest Bazin" (The question of the roller ship is discussed, and illustration given. The theory as presented shows the remarkable result produced by rotation, and the question is considered mainly in relation to speed). Trans—Nov. 20. 1400 w. 30 cts.

9486. The Stability of Ships (Abstract of address by Mr. James Reid at the meeting of the graduates' section of the Scottish Inst. of Engs. and Shipbuilders. Defines and discusses the subject and considers that safer vessels were never built than those of the present. Related matters of interest are briefly considered). Eng, Lond—Nov. 20. 2400 w. 30 cts.

9567. Marine Engineers' Qualifications (Brief extracts from letters from practical men of various classes on the subject of marine engineers' training). Engng—Nov. 27. 1600 w. 30 cts.

9583. Steamship Passages (Comments on the passages of the present year and reviews the progress since the beginning of Victoria's reign). Ill Car & Build—Nov. 27. 2000 w. 30 cts.

9584. Ocean Sailings (Reviews the record since 1838). Ill Car & Build—Nov. 27. 1000 w. 30 cts.

9585. Shipbuilding (A discussion, at some length, of the timber supply for shipbuilding, by Mr. G. C. Mackrow. Illustrated). Ill Car & Build—Nov. 27. 4200 w. 30 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

9160. Practical Theory of Steam-Making from Shovel to Stop-Valve. Winthrop Thayer (Abstract of a paper read before the N. E. Cotton Mfrs. meeting. Directions for securing perfect combustion and intense heat. Advocating forced draught). Lord's Mag—Nov. 2300 w. 15 cts.

9275. Boiler Incrustation and Its Removal. (Report of the Bavarian Society for Boiler Inspection). Am Mfr & Ir Wld —Nov 13. 1800 w. 15 cts.

9285. Burning Cheap Fuel. W. H. Wakeman, in the "Woodworker" (A discussion of the use of cheap fuel for steam-making purposes, the conditions that favor it and the causes of failure). Safety V—Nov. 2500 w. 15 cts.

9357. Water Hammer. (Some experiments to show when it may occur). Bos Jour of Com—Nov. 21. 1200 w. 15 cts.

9422. Efficiency of the Boiler Grate. William Wallace Christie (Data collected from 108 boiler tests, paying particular attention to the pounds of coal burned per square foot of grate). Am Soc of Mech Engs—Dec. 1200 w. 45 cts.

9432. Ancient Pompeiian Boilers (Ill.) W. T. Bonne. (Proof that the water-tube principle was understood and appreciated by the Greeks and Romans two thousand years ago). Am Soc of Mech Engs—Dec. 2200 w. 45 cts.

9479. Steel for Boilers and Fire Boxes. T. L. Condron (The material for this paper has been collected from the motive power departments of several railroads, a few of the locomotive works and steel manufacturers. Specifications of the Am. Ry. Mas. Mech's. Ass'n. for boiler and fire-box steel are also given. Jour W Soc of Engs—Oct. 2800 w. 45 cts.

9481. Explosion of a Kier at a Paper Mill, Bolton. (Report of an investigation with regard to the bursting of a revolving rag boiler or kier, which occurred at the Springfield Paper Works, Bolton.) Eng'ng. —Nov. 20. 5000 w. 30 cts.

9504. Starting and Closing Boiler Tests (A discussion as to whether the test should be started with clean grates, with Prof. Carpenter's opinion.) Bos Jour of Com—Nov. 28. 1200 w. 15 cts.

9505. Boiler Making. Henry J. Hartley (Old and new methods contrasted). Bos Jour of Com—Nov. 28. 2200 w. 15 cts.

9547. A New High Temperature Furnace. H. L. Gantt (A study of the actions carried on in the electrical furnaces. and other high temperature furnaces. Followed by discussion). Jour Fr Inst—Dec. 3500 w. 45 cts.

9549. The Factory Chimney. Robert Kunstman (The functions and construction of a serviceable factory chimney are considered). Brick—Dec. 3300 w. 15 cts.

COMPRESSED AIR.

9518. The Best Air Compressor for

Shop Service. Frank Richards (A criticism of some ideas advanced in the discussion on compressed air, at the monthly meeting of the R. R. Club, with the writer's personal opinions). Am Mach—Dec. 3. 1500 w. 15 cts.

9535. Compressed Air Motors. Carl Snyder (Illustrated description of different uses of compressed air, with details of development). Harper's Weekly—Dec. 5. 15 cts.

9551. The Cost and Profit of Compressed Air (Quotations from papers of G. A. True and C. W. Shields, read before the Western Foundrymen's Assn., which are strong arguments for the use of compressed air). Ry Mas Mech—Dec. 2500 w. 15 cts.

ENGINES AND MOTORS.

9155. The Economy of the Modern Engine-Room. E. J. Armstrong (Showing the significance and value of duty tests for engines and boilers). Eng Mag—Dec. 2800 w. 30 cts.

9202. Some Modern Modifications and Accessories of the Steam Engine. J. Warren (A detailed description of a Willans triple expansion engine, and the Parsons steam turbine). Elec, Lond—Oct. 23. 1800 w. 30 cts.

9234. On Crank Shafts. John H. Macalpine. (The investigation deals with the estimation of the various stresses which are induced in the crank shaft of an engine when running. The principal practical result is the ascertaining of the dimensions of a set of crank shafts which, under working conditions, will not in any part have stresses rising above a definite value). Jour Am Soc of Naval Engs—Nov. Serial. 1st part. 16000 w. $1.25.

9238. About Engine Governors (Calls attention to some of the causes which impede their action or hinder them from working). Bos Jour of Com—Nov. 14. 1000 w. 15 cts.

9303. The Balancing of Beam Engines (Answer to an inquiry regarding the method of calculating the balance weight of beam engines. Shows how the work is done). Am Mach—Nov. 19. 1500 w. 15 cts.

9353. Breakdowns of Stationary Steam Engines. Michael Longridge (Read before the British Inst. of Mech. Engs. A short digest of the author's experience. Statistics derived from the last thousand breakdowns with which the writer had to deal previous to Dec. 31, 1894, are given, with statements of facts and explanations). Col Guard—Nov. 13. Serial. 1st part. 4700 w. 30 cts.

9372. Horseless Road Locomotion. A. R. Sennett (Read before the British Assn. Illustrated description of vehicles and what has been done in this field). Ind & Ir—Nov. 13. 10500 w. 30 cts.

9373. Motor Cars and the Advantages of High-Speed Oil Engines. William Norris (The author illustrates, with the Pennington oil motor, how the force of inertia of the moving parts acts as a regulator and modifier of shock in the transmission of the explosive force to the crank). Ind & Ir—Nov. 13. 1400 w. 30 cts.

9374. Old-Time Motor Cars (Illustrated description). Ind & Ir—Nov 13. 1700 w. 30 cts.

9375. Present Time Motor Cars (Illustrated description of various makes). Ind & Ir—Nov. 13. 4000 w. 30 cts.

9376. Self-Propelling Vehicles. A. R. Sennett (Interesting review of prophecies and progress). Ind & Ir—Nov. 13. 8000 w. 30 cts.

9425.—Steam Engine Governors. Frank H. Ball (An investigation of the governing forces and their relations to each other, with conclusions reached. Illustrated). Am Soc of Mech Engs—Dec. 4000 w. 45 cts.

9508. Locomotive Repairing Work. A. H. Newsam Smith (Read before the Inst. of Junior Engs. The writer confines himself to two classes of English engines largely used now, giving description of the main features of the work). Prac Eng—Nov. 20. Serial, 1st part. 4000 w. 30 cts.

9546. The Standard of Efficiency for Steam Engines and Other Heat Motors. R. H. Thurston (The essentials of a satisfactory standard are stated, and standards discussed and studied in some detail in part 1st). Jour Fr Inst.—Dec. Serial. 1st part. 4000 w. 45 cts.

9578. Recent Developments in Mechanical Road Carriages. W. Worby Beaumont (A full paper, reviewing the causes that have retarded the progress of invention, the different races and trials of motor carriages, the construction of the vehicles, with illustrations, and subjects related). Jour Soc of Arts—Nov. 27. 11500 w. 30 cts.

POWER AND TRANSMISSION.

9174. Hydraulic Power Transmission. Gustave Kaufman (From a paper read before the Engs.' Soc. of W. Penn. Describes briefly a system of power transmission which is largely in use in England. It is the distribution of water at very high pressures, from 700 to 2000 pounds per square inch). Ir Age—Nov. 12. 3000 w. 15 cts.

9364. On Cheap Steam Power. J. S. Raworth (Read before the Northern Soc. of Elec. Engs. A discussion as to whether the cost of steam power can be reduced). Elec Eng, Lond—Nov. 13. 3800 w. 30 cts.

9413. The New Power Plant of the

Washington Mills Co., Lawrence, Mass. (Illustrated description of the power plant of what is claimed to be the largest woolen mills in the world). Eng News—Nov. 26. 2000 w. 15 cts.

9418. Friction Horse-Power in Factories. C. H. Benjamin (Tabular data, with explanations, secured in a series of experiments made to determine the ratio of the power required to drive shafting and belts in various factories to the total power consumed). Am Soc of Mech Engs—Dec. 1500 w. 45 cts.

9506. Ropes and Rope Driving. G. H. Kenyon (Part first reviews briefly the history and deals with positive motion, wedging action and construction of grooves). Mech Wld—Nov. 20. Serial, 1st part. 1800 w. 30 cts.

SHOP AND FOUNDRY.

9151. Six Examples of Succesful Shop Management, III. Ill. Henry Roland (Showing the methods of the Yale & Towne Co. in dealing with their employees). Eng Mag—Dec. 5300 w. 30 cts.

9180. Cost Keeping—Some Large Air Hoists—A Right-Angle Coupling—A Rack Cutter—The Centers of Arbors. S. T. Freeland (Brief consideration of subjects named). Am Mach—Nov. 12. 2600 w. 15 cts.

9181. Pump Balancing. W. H. Booth (The subject is discussed and an illustrated description of arrangement of pump given). Am Mach—Nov. 12. 1800 w. 15 cts.

9291. Screws and Screw-Making. L. A. Murray (The history of screw-making is briefly given, its requirements stated, with description of the method of manufacture). Sib Jour of Engng—Nov. 3000 w. 30 cts.

9304. Bicycle Brazing. Hugh Dolnar (Illustrated description, with historical review of the art). Am Mach—Nov. 19. 2400 w. 15 cts.

9406. Some Forms of Screw-Swaging Machines (Illustrated description of the machines and of their operation). Ir Age—Nov. 26. 900 w. 15 cts.

9409. Press and Die Work on Bicycles (An illustrated outline of the general principles). Am Mach—Nov. 26. 2300 w. 15 cts.

9410. Some Features of a Modern Shop—Casting Storage, Stock Room, Points About Scraping. S. T. Freeland (Illustrated description of some features in a Cincinnati shop). Am Mach—Nov. 26. 2000 w. 15 cts.

9411. "Limit" Taps. Horace L. Arnold. (Illustrated description of taps of this form, which the writer claims will produce tapped holes varying in diameter only within fixed limits). Am Mach—Nov. 26. 2500 w. 15 cts.

9429. Contraction and Deformation of Iron Castings in Cooling from the Fluid to the Solid State. Francis Schumann. (The results of twelve years of observation and research by the writer, with conclusions. Am Soc of Mech Engs—Dec. 3800 w. 45 cts.

9431. Experimental Investigation of the Cutting of Bevel Gears with Rotary Cutters. Forrest R. Jones and Arthur L. Goddard. (Abstract of a thesis presented by Mr. Goddard for the degree of B. S. in mechanical engineering. Describes apparatus constructed and used experimentally in order to obtain the proper setting for gears of different centre angles). Am Soc of Mech Engs—Dec. 2500 w. 45 cts.

9444. Improvement of Cupola Practice. James A. Beckett. (A response to the circular letter asking for suggestions for improvement in cupola practice in the foundry. The writer thinks the greatest need is a more general knowledge of cause and effect in the matter of combustion of fuel in the cupola; in fact, more intelligence in the workers). Ir Tr Rev—Nov. 26. 1800 w. 15 cts.

9459. Some Pencil Sketches of Failures. H. Hansen. (A study of bad castings and their causes). Foundry—Nov. 1400 w. 15 cts.

9460. The Influence of Heat Upon Cast Iron. S. S. Knight. (Observations upon the foundry methods in use, with suggestions set forth, which the writer claims to be an improvement). Foundry—Nov. 1600 w. 15 cts.

9507. The Manufacture of Iron and Steel Tubes. Edward C. R. Marks. (The subject will be confined to butt and lap welded tubes of iron, open or close jointed and consolidated tubes, and processes for the production of weldless or seamless steel tubing for the construction of bicycle frames and for other purposes). Prac Eng—Nov. 20. Serial. 1st part 2000 w. 30 cts.

9516. "Planed" Bevel Gear Teeth. George B. Grant. (The definition of "planed" as applied to gear teeth is given, and the four methods now in use for cutting the teeth of bevel gears are explained). Am Mach—Dec. 3. 5500 w. 15 cts.

9517. The Construction of an Accurate Large Spur Gear (An outline of the methods employed in the construction of a difficult piece of work). Am Mach—Dec. 3. 1200w. 15 cts.

9521. Making Armature Disks (Outline of the various methods, with illustrations of several modern machines adapted to this work). Am Mach—Dec. 3. 1400 w. 15 cts.

9591. Improvement in the Foundry. W. J. Keep (Calls attention especially to the loss occasioned by bad castings). Mach—Dec. 1200 w. 15 cts.

9633. The Stripping of Bushes (Customary practice, with suggestions for special cases). Prac Eng—Nov. 27. 900 w. 30 cts.

MISCELLANY.

9182. Atoms and Molecules. (Abstract from article in N. Y. Sun, by Robert S. Ball. Facts which should be understood by mechanics.) Am Mach—Nov. 12, 1800 w. 15 cts.

9199. Superheating. Michael Longridge. (Explains how superheated steam differs from saturated steam, its action and the benefits to be derived.) Eng's Gaz—Nov. 2500 w. 30 cts.

9212. The Value of the Steam Jacket on a Locomotive Engine. Prof. T. Hudson Beare and Mr. Bryan Donkin. (Report of the Research Committee of the Inst. of Mech. Engs. Description of the experiment and the general results.) Eng, Lond—Nov. 6. 2200 w. 30 cts.

9227. Superheated Steam. W. E. Burgess. (The writer proposes in the following articles to show in what way the use of superheated steam increases the economy in the engine, to give the best methods of investigating and comparing the performance of engines using both saturated and superheated steam, by means of heat charts; to examine the actual efficiencies of engines using superheated steam and discuss the influence of the superheater on the general economy of a power station.) Elec Engng—Nov. Serial. 1st part. 3000 w. 15 cts.

9228. Some Notes on Fly Wheels. Irving A. Taylor. (Examines some points which the writer thinks were not carefully considered in Mr. Williams's article in the August number of Elec Engng.) Elec Engng—Nov. 1200 w. 15 cts.

9229. Methods of Fuel Testing. Arthur V. Abbott and Franz J. Dommerque. (Describes the methods in vogue for the determination of calorific power, and shows the importance of the work in relation to power production.) Elec Engng—Nov. 3400 w. 15 cts.

9235. Tests of Riveted Joints Made at the Watertown Arsenal, Mass., for Messrs. Edward Kendall & Sons, Cambridgeport, Mass., May 29, 1896. (Description and results of tests, supplied by the designers and makers of the joints). Jour Am Soc of Naval Engs—Nov. 2200 w. $1.25.

9239. The Engineer of To-Day (His responsibility and what he is required to know). Bos Jour of Com—Nov. 14. 2800 w. 15 cts.

9241. The Recent French Motor Car Competition (An account of the arrangements, the preliminary test and the long race. In this trial the importance of pneumatic tires was shown, and also the fact is noted that petroleum entirely superseded steam). Engng—Nov. 6. 3300 w. 30 cts.

9308. The First Bicycle. From "La Nature" (Illustrated description of machines of 1819, with historic data from book of M. Baudry de Saunier). Sci Am Sup—Nov. 21. 600 w. 15 cts.

9321. The application of Suction Pipes to the Handling of Grain at Millwall Docks, England (Description, with illustrations of the appliances. Taken from paper of Frederick Eliot Duckham, as published in Trans of Inst, of Civ Engs). Eng News—Nov. 19. 2400 w. 15 cts.

9334. Worcester Polytechnic Institute Hydraulic Laboratory (illustrated description). Eng Rec—Nov. 21. 1200 w. 15 cts.

9342. Boat Channel Dredgers for the Colonies (The need of type of dredger for special work is shown, and the conditions are stated). Ind & East Eng—Oct. 17. 1000 w. 45 cts.

9347. Expanded Metal (An illustrated description of machine devised by Mr. Golding). Engng—Nov. 13. 800 w. 30 cts.

9377. Methods of Determining the Dryness of Saturated Steam. Osborne Reynolds (Abstract of a paper read before the Manchester Literary and Philosophical Society. A discussion with consideration of conditions necessary for securing accuracy). Prac Eng—Nov. 13. 500 w. 30 cts.

9420. Paper Friction Wheels. W. F. M. Goss (Some applications of the paper friction wheel are presented diagrammatically, with brief description of their action, experiments and a summary of results). Am Soc of Mech Engs—Dec. 1800 w. 45 cts.

9423. A Two Hundred-Foot Gantry Crane. John W. Seaver (Illustrated description of the plant of the Cambria Iron Co., of Johnstown, Pa., installed in their storage and loading yard). Am Soc of Mech Engs—Dec. 2800 w. 45 cts.

9424. Method of Determining the Work Done Daily by a Refrigerating Plant and Its Cost. Francis H. Boyer (Describes a method of obtaining the amount of work accomplished daily, used in the abbattoir of John P. Squire & Co., East Cambridge, Mass). Am Soc of Mech Engs—Dec. 1100 w. 45 cts.

9426. Some Special Forms of Computers. F. A. Halsey (Describes a type of computer for solving mechanical problems. Cox's Strength of Gear Computer). Am Soc of Mech Engs—Dec. 1100 w 45 cts.

9428. Calibration of a Worthington Water Meter. John A. Laird (Results of a series of meter calibrations. The meter tested was a Worthington, made entirely of brass, for hot water, and purchased for testing purposes). Am Soc of Mech Engs —Dec. 500 w. 45 cts.

9430. The Moment of Resistance. C. V. Kerr (Two methods, the analytical and the graphical, are offered for determining the resisting moment directly from the cross section of a given beam.) Am Soc of Mech Engs—Dec. 2200 w. 45 cts.

9502. On Certain Physical Difficulties in the Construction of Large Guns. W. Le Conte Stevens (Describes the Treadwell plan for gun construction, which has been universally adopted, and the difficulties met with in shrinking the jacket and adjusting it to the cold tube). Science—Nov. 27. 2800 w. 15 cts.

9519. Formulae for Ball Bearings. H. Rolfe (Some supplementary remarks called forth by Mr. Babbitt's letter on this subject, taking into account the matter of clearance between the balls). Am Mach—Dec. 3. 1000 w. 15 cts.

9520. Diagram of Proportions of Elliptical Arms (Diagram for determining the dimensions of elliptical arms for belt or rope pulleys, or similar wheels used for power transmission. From the reference book of S. E. Freeman, of the Todd & Stanley Mill Furnishing Company, St. Louis, Mo.) Am Mach—Dec. 3. 500 w. 15 cts.

9522. Foundry Costs. (Abstracts of a series of reports made to the New England Foundrymen's Association). Ir Age—Dec. 3. 3500 w. 15 cts.

9540. Abrasion and Etching Tests of Wrought Iron and Steel Car Axles (Report of L. R. Pomeroy of tests made in the laboratory of the Cambria Iron Co., with illustrations). RR Gaz—Dec. 4. 1200 w. 15 cts.

9587. Computing Horse-Power from the Indicator Diagram—Approximate Water Consumption. F. F. Hemenway (Directions for computations, with plan for approximate water consumption used by the Buckeye Engine Co.). Loc Engng —Dec. 1000 w. 30 cts.

9592. A System of Drawing-Room Records (The plan described is the outgrowth of a process of trial covering an extended period). Mach—Dec. 1500 w. 15 cts.

9593. Steam Economics. W. H. Booth (General discussion of the subject). Mach —Dec. 1800 w. 15 cts.

9616. The Commercial Organization of Factories (Review of a book by J. Slater Lewis. It is for the use of manufacturers, directors, engineers, secretaries, accountants, draughtsmen, &c.) Ir & Coal Trds Rev—Nov. 27. 4000 w. 30 cts.

9618. Some Common Fallacies with Regard to Steam and the Steam Engine, and the Lessons They Teach (Calls attention to a few fallacies, some of which are a source of danger to the inexperienced). Ind & Ir—Nov. 27. 1500 w. 30 cts.

9634. Five Years Apprenticeship in an Engine Room. M. W. Danielsen (The work necessary to perfect an engineer is briefly reviewed and information given on several subjects). Age of St—Dec. 5. 1800 w. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

9195. Washing and Sizing Coal. F. W. Hardwick (A lecture delivered at Mansfield, Eng. Various methods employed in the mechanical separation and removal of impurities. Descriptions of leading types of washing appliances, their construction and the principles of their action in washing and sizing). Col Eng—Nov. 5000 w. 30 cts.

9222. The Baum Coal Washing Apparatus (Illustrated description). Col Guard —Nov. 6. 2500 w. 30 cts.

9359. Conversion of Culm Into Gas. N. W. Perry (Extract from a paper read at meeting of the Anthracite Coal Operators Ass'n. A study of the question leads the writer to the conclusion that the solution of the problem of the utilization of anthracite culm lies in its conversion first into fuel gas, to be burned in gas engines, and transmitting the energy electrically). Am Mfr & Ir Wld—Nov. 20. 3300 w. 15 cts.

9427. The Washing of Bituminous Coal by the Luhrig Process. J. V. Schaefer (A detailed description of the latest plant built on the Luhrig system, with a brief consideration of the nature of the impurities, the means to remove them and the advantages of cleaned coal.) Am Soc of Mech Engs—Dec. 4200 w. 45 cts.

9469. A New Work on the Coal Industry (Review of a work by H. F. Bulman and R. A. S. Redmayne. Many extracts are given and very favorable comment). Ir & Coal Trds Rev—Nov. 20. 4300 w. 30 cts.

9470. Ashington Colliery, Northumberland (Detailed description of the three pits). Col Guard—Nov. 20. 2700 w. 30 cts.

9574. The Heidelberg Coalfield, Transvaal. Thomas B. Shipley (Descriptive account). Col Guard—Nov. 27. 1400 w. 30 cts.

9577. Colliery Working in the Pas-de-

Calais. M. E. Duporeq (From the official report. Economical and technical observations, with description). Col Guard—Nov. 27. 1700 w. 30 cts.

9621. Coal Mining by Machinery (A brief outline of the operation of coal getting is given, with comment on the limited progress yet made in this work. Broadly classifies all coal cutters under three heads and gives particulars relating to their use). Min Jour—Nov. 28. 1700 w. 30 cts.

9625. The Analysis of Coke. George C. Davis (Read before the Foundrymen's Assn. Means for determining its suitability for use in blast furnace or cupola. Describes the proximate analysis of coke). Am Mfr & Ir Wld—Dec. 4. 1200 w. 15 cts.

COPPER.

9217. Improvements in the Electrolytic Refining of Copper. Titus Ulke (Reviews recent improvements). Eng & Min Jour—Nov. 14. 900 w. 15 cts.

9438. Present Method of Treating Slimes from the Copper Refineries. Titus Ulke (The three ways in which slimes are refined when lead works are run in connection with the copper refinery are briefly stated). Eng & Min Jour—Nov. 28. 1700 w. 15 cts.

GOLD AND SILVER.

9185. The Cyanide Process Patents Declared Void in the Transvaal (An account of the use of this process in South Africa, the large amount of gold recovered by it, the heavy royalties, and the successful effort to have the patent set aside in South Africa. It is believed that it will result in a general overthrow which will cause immense additions to the world's stock of gold). Sci Am—Nov 14. 2300 w. 15 cts.

9196. Summit District Gold Regions (An epitome of a description of the ore deposits of Summit District, Rio Grande County, Colorado, by R. C. Hills. Prepared by Prof. Arthur Lakes. Illustrated). Col Eng—Nov. 1800 w. 30 cts.

9214. The Cyanide Patent Decision in the Transvaal (An account of the case and the effect the decision will have in the Transvaal, with some information relating to other countries, and a brief summary of the history of the cyanide patents). Eng & Min Jour—Nov. 14. 1800 w. 15 cts.

9251. The Silver-Lead Mines of New South Wales (Illustrated historical account of the Broken Hill Mine). Aust Min Stand—Sept. 2500 w. 30 cts.

9252. The Gippsland (Vic) Goldfields. Donald Clark (Describes the mining prospect and gives the history of the region. It has proved a good field for miners, but is not a field for the capitalist). Aust Min Stand—Sept. 2800 w. 30 cts.

9254. The Greatest Gold Mine in Australia (History of the Discovery of Mount Morgan as told by Edwin Francis Morgan, with scientific theories on the origin of the deposit. Illustrated). Aust Min Stand—Sept. 4000 w. 30 cts.

9255. The Saving of Gold in Refractory Ore Bodies. Dr. Storer (Illustrated brief description of the two methods now used). Aust Min Stand—Sept. 900 w. 30 cts.

9256. Treatment of Broken Hill Sulphide Ores. F. J. Greenaway (The importance of the treatment and the operations, with their advantages and disadvantages). Aust Min Stand—Sept. 1700 w. 30 cts.

9258. The Ballarat Goldfield. William Bradford (Illustrated description of its main features). Aust Min Stand—Sept. 3800 w. 30 cts.

9264. The Alluvial Gold of Otago, N. Z From the New Zealand Mining Journal (An attempt to explain the presence of so much gold in the rich placers, rivers and creeks). Aust Min Stand—Oct. 8. 2300 w. 30 cts.

9293. Recent Development of Mining in Ontario (Information from the report of Dr. A. P. Coleman to the Bureau of Mines relating to the goldfields of this region). Can Eng—Nov. 2000 w. 15 cts.

9322. The Gold Mines of North Carolina. Maxwell J. Gorman (A review of gold mining in this locality, with descriptions of the mines of greatest promise). Eng News—Nov. 19. 3300 w. 15 cts.

9336. Oceanic Gold. Henry Wurtz (A letter to the editor calling attention to an article in the London Chemical News by Mr. A. Liversidge with discussion of the subject and matters related). Eng & Min Jour—Nov. 21. 1800 w. 15 cts.

9370. Gold Mining in British Guiana (Concludes that with free milling, gold of a high grade of value, such as is reported to prevail in the northwest district of British Guiana, and moderate working expenses, the investor may look for success). Min Jour—Nov. 14. 2400 w. 30 cts.

9390. The Loss of Flour Gold in Australian Mines. J. Cosmo Newberry (Discusses the causes of loss in gold mining and what is done to save gold). Aust Min Stand—Oct. 15. 2200 w. 30 cts.

9452. Some Economic Features in Connection with Mining on the Witwatersrand Gold-Fields, South African Republic. Edgar P. Rathbone (Read before the Inst. of Min. & Met. Deals with the mining of gold-bearing conglomerates on the Witwatersrand, Klerksdorp and Heidelberg goldfields collectively). Min Jour—Nov. 21. 2800 w. 30 cts.

9511. The Smuggler-Union Mines, Telluride, Colo. J. A. Potter (Data relative to this property and the treatment of its ore. Read at Colorado meeting). Min Ind & Rev—Nov. 26. 2600 w. 15 cts.

9533. The Liquation of Certain Alloys of Gold. F. H. M. (A discussion of valuable facts brought out in a paper by Edward Matthey in "Philosophical Transactions." Experiments are given and conclusions drawn by Mr. Matthey). Can Min Jour—Nov. 1000 w. 30 cts.

9542. The Silver Mines at Joachimstahl, Bohemia. R. Helmhaeker (Historical sketch with account of the present state of mining). Eng & Min Jour—Dec. 5. 3000 w. 15 cts.

9543. The Bald Mountain District, Wyoming. Fred D. Smith (Describes district and examines statements made by Mr. Tewksbury, manager of the Fortunatus Co. His claims that gold is present in the rocks of this region are not supported by the investigations of the writer). Eng & Min Jour—Dec. 5. 1600 w. 15 cts.

9649. The Gold Fields of South Africa. George F. Becker, in the Cosmopolitan (The gold deposits are described and a few statistics given with bright prophecies for the future). W Min Wld—Dec. 5. 2000 w. 15 cts.

IRON AND STEEL.

9292. Progress in Blast Furnace Construction. W. O. Amsler (Improvements in design and construction are reviewed, with description of the furnace as at present constructed, and improvements coming into use). Sib Jour of Engng—Nov. 4000 w. 30 cts.

9306. Iron and Steel in China and Japan. R. V. B. (The condition of the market for these products is discussed, with a review of the history of these industries in the countries named, and the changes brought about in China). Ir Age—Nov. 19. 2000 w. 15 cts.

9358. Fluid Compression of Steel. H. K. Landis (A criticism of statements made by W. F. Durfee and published in the "Journal of the Franklin Inst."). Am. Mfr & Ir Wld—Nov. 20. 1800 w. 15 cts.

9360. The Iron Industry of the Ural Mountains. J. Kowarsky (Describes briefly the ore, mines and methods). Am Mfr & Ir Wld—Nov. 20. 1600 w. 15 cts.

9433. Historical and Technical Sketch of the Origin of the Bessemer Process. Sir Henry Bessemer (A brief account of the early origin of the Bessemer process of steel manufacture as developed at the bronze powder manufactory in London. Illustrated). Am Soc of Mech Engs—Dec. 6000 w. 45 cts.

9436. The By-Products of the Blast Furnace. A. Humboldt Sexton (The importance of the blast furnace in the industries; the vastness of the material which they consume and reproduce in another form; a study of what goes on in the furnace, value and use made of the by-products; with history of the pioneers of the recovery process). Phil Soc of Glasgow. 4500 w. 45 cts.

9468. Recollections of the Anthracite Pig-Iron Industry. E. Roberts (Information on some points, with remarks relative to the costs and yields of actual workings at Guiscedwyn and in America). Ir & Coal Trds Rev—Nov. 20. 2700 w. 30 cts.

9603. New Method for Determining the Amount of Sulphur Contained in Iron (Eine neue Methode zur Bestimmung des Schwefels im Eisen). Wilh. Schulte (Description of new chemical compounds used for this purpose). Stahl und Eisen. Nov. 1, 1896. 4300 w.

9632. American Rolling Mills. Samuel T. Wellman (Read before the Inst. of Civ Engs. Part first traces the development of labor-saving appliances in this industry, and specially describes the work of the Joliet Works of the Illinois Steel Co., with illustration of ingot charging machine). Ir & St Trds Jour—Nov. 28. Serial. 1st part. 2200 w. 30 cts.

MINING.

9159. English Practice in Transmitting Power in Mines (Reviewing Mr. Rankin Kennedy's discussion of steam, compressed air and electricity as motive powers for transmission purposes). Eng Mag—Dec. 3700 w. 30 cts.

9194. The Crown Point Mine and Knickerbocker Tunnel, Idaho Springs, Colo. Arthur Lakes (The situation of the latter and a comparison of the circumstances under which it is driven, with numerous other past and prospective tunnel schemes). Col Eng—Nov. 2000 w. 30 cts.

9216. The Avery Island Salt Mine and the Joseph Jefferson Salt Deposit Louisiana (Illustrated description of the mine, with brief history and account of the system of mining). Eng & Min Jour—Nov 14. 1700 w. 15 cts.

9220. Sinking and Lining a Shaft at a French Colliery Aime Gardon (From a communication to the Societe de l'Industrie Minerale. Description with illustrations). Col Guard—Nov. 6. 4800 w. 30 cts.

9221. Experiments Bearing on the Causes of Explosions. J. Coquillion (Explanation of phenomenon produced by the uniting of oxygen and hydrogen). Col Guard—Nov. 6. 900 w. 30 cts.

9352. Romer's Automatic Apparatus for Insuring Safety in Winding (Describes an apparatus which prevents the rising cage from coming to bank at too great a speed, and, to a certain extent, a too sharp setting down at the landing of the descending cage). Col Guard—Nov. 13. 3000 w. 30 cts.

9354. Shaft Sinking at the Royal Brown Coal Pit near Loderburg, Germany. From Zeitschrift fur Burg-Hutten-und Salinenwesen (Describes the sinking of a shaft under peculiar difficulties, owing to the presence of a layer of fine-grained quicksand). Col Guard—Nov. 13. 1200 w. 30 cts.

9355. Laying Out Pit Bottoms. W. Stewart (The importance of the subject in the laying out of a new colliery is presented, with discussion of main points and a brief description of the laying out of the Vivian Pit, Abertillery). Col Guard—Nov. 13. 3300 w. 30 cts.

9379. The Covering of Up-Cast Pits. George H. Hollingworth (Describes some of the means devised for the covering of up-cast pits, where used for winding purposes, with the object of so closing the top as to prevent loss or leakage of air without materially interfering with the banking operations). Prac Eng—Nov. 13. 1600 w. 30 cts.

9394. Electricity vs. Compressed Air—Actual Results in a Mine of the Colorado Fuel and Iron Co. Lewis Searing, with editorial (An illustrated account of tests favorable to electricity. Elec Eng—Nov. 25. 2400 w. 15 cts.

9437. A Log Dam for a Mining Power Plant. Robert Gilman Brown (Illustrated description of additions made to the power plant of the Standard Consolidated Mining Co., at Bodie, Cal. An important part of the work was the construction of a new dam). Eng & Min Jour—Nov. 28. 1200 w. 15 cts.

9472. Filling Worked Seams with Mining Waste Arnao Colliery (Asturias), Spain. (Describes a method made necessary in working a seam with a thin cover rock under the sea, the circumstances being complicated by the strong tendency of this coal to ignite spontaneously). Col Guard—Nov. 20. 1500 w. 30 cts.

9475. Safety apparatus for Winding Engines. (From a communication by Herr Baumann to the upper Silesian Assn. of German Engs., published by "Gluckauf." Illustrated description). Col Guard—Nov. 20. 1200 w. 30 cts.

9532. Mine Drainage. Hans C. Behr. (Report to California Mining Bureau. Describes water-raising machines used in mining; conditions affecting the working of pumps; starting, priming and draining pumps and desirable features. Also different materials for pipes, with illustrations, pipe connections, flanges, &c.) Can Min Jour—Nov. Serial. 1st part. 3800 w. 30 cts.

9573. Adaptation of an Air Shaft for Winding. M. Prosper Vanhassel. (From a communication to the Societe de l'Industrie Minerale, Saint Etienne. Illustrated description of methods). Col Guard—Nov. 27, 4300 w. 30 cts.

9575. Underground Haulage at Cannock and Rugeley Collieries. Robert S. Williamson. (From a paper read before the South Staffordshire and East Worcestershire Institute of Mining Engs. The systems used are main-and-tail-rope endless rope by power, and endless rope on self-acting inclines, &c. The powers used are steam, compressed air and electricity). Col Guard—Nov. 27. 2500 w. 30 cts.

9576. Chopwell Colliery, Durham. J. R. Gilchrist (From the Journal of the British Society of Mining Students. Describes buildings and plant, boilers, shaft guides, headgear, screening, waterworks, railway and incline). Col Guard—Nov. 27. 2000 w. 30 cts.

MISCELLANY.

9164. The Specific Heats of the Metals. F. A. Waterman. (Considers the purity of the metals used; the determination of temperatures; the methods employed and results obtained, with tabulated determinations). Phys Rev—Nov.-Dec. 5000 w. 45 cts.

9166. The Viscosity of Mercury Vapor. A. A. Noyes and H. M. Goodwin. (Read at the Buffalo meeting of the Am. Assn. for the Adv. of Science and at the meeting of the Am. Acad. of Arts and Sciences. Investigations undertaken to determine whether a marked difference in value exists in the case of gases with monatomic and those with polyatomic molecules), Phys Rev—Nov.-Dec. 2200 w. 45 cts.

9193. General Practice in Surveying Mineral Lands and Gold and Silver Mines. Auguste Mathez (A description of the instruments, their use, adjustment and care, with explanations of the principles involved in practical work. Illustrated). Col Eng—Nov Serial. 1st part. 2300 w. 30 cts.

9215. The Phosphate Deposits in Maury County, Tennessee. J. B. Killebrew (An account of the discovery and character of the rock; the locality covered and the work in progress). Eng & Min Jour—Nov. 14. 1500 w. 15 cts.

9226. The West Australian Mining Industry. C. C. Longridge, with editorial comments (Discusses and objects to statements made by Mr. Van Oss in his article on the Rand Mining Industry, which appeared in the Nineteenth Century. Tabular statement of crushings is given.) Min Jour—Nov. 7. 1400 w. 30 cts.

9231. The Westralian Mining "Boom." S. F. Van Oss (An examination of the methods pursued in creating the 80,000,000 shares of stock, and the means adopted to distribute them among the public). Nineteenth Cent—Nov, 4000 w. 45 cts.

9253. The Mineral Fields of the West Coast of Tasmania (General description of the fields, setting forth the principal facts as to their topography, geological structure, and the local conditions under which mining has to be carried on). Aust Min Stand—Sept. 5000 w. 30 cts.

9259. Geology as Applied to Mining. James Stirling (The importance of a knowledge of geology to the mining engineer, and the facts that are helpful to him). Aust Min Stand—Sept. 3500 w. 30 cts.

9260. The Greatest Tin Mine in the Southern Hemisphere (Description, with illustrations, of the Mount Bischoff Mine, Tasmania). Aust Min Stand—Sept. 3500 w. 30 cts.

9261. A Copper-Silver-Gold Mountain, Tasmania (Description of the mines of the Mount Lyell Company, on the west coast of Tasmania). Aust Min Stand—Sept. 1600 w. 30 cts.

9262. The Origin of Valuable Mineral Deposits. Frederick Danvers Power (A review of the hypotheses advanced, with the arguments for and against them). Aust Min Stand—Sept. Serial, 1st part. 4500 w. 30 cts.

9263. The Bituminous Shales of New South Wales (Deals with the so-called bituminous shale, which contains volatile, hydro-carbon in large quantities, variously known as torbanite, boghead mineral, joadja mineral, petroleum oil, cannel coal, and shale, and is now only procurable in New South Wales. Illustrated). Aust Min Stand—Oct. 1. 2000 w. 30 cts.

9276. The Velna Process for the Manufacture of Briquettes from Waste Coal and Mineral Tar (L'Industrie describes a process devised by the chemist Velna, who uses petroleum or mineral tar only for enriching culm and other inferior combustibles, and produces briquettes from this material, the heating power of which is 30 per cent. higher than that of good coal). Am Mfr & Ir Wld—Nov. 13. 1100 w. 15 cts.

9310. Barre, Vermont, Granite Quarries. From the Burlington, Vt., "Free Press." (Interesting account of the granite industry and the social conditions affecting it). Stone—Nov. 3300 w. 30 cts.

9311. President J. H. Neff's address before the California Miners' Association (Largely devoted to the results accomplished by the organization). Min & Sci Pr—Nov. 14. 4400 w. 15 cts.

9337. A Sketch of Mine La Motte, Missouri. Charles R. Keyes (Describes one of the most famous lead mines of the country). Eng & Min Jour—Nov. 21. 2000 w. 15 cts.

9338. The Long-Wall Coal-Mining Region of Grundy County, Illinois (Illustrated description). Eng & Min Jour—Nov. 21. 1500 w. 15 cts.

9344. Possibilities of Cupola Practice (A letter from Dr. Edward Kirk on the use of hot-blast, and a letter from Herbert M. Ramp showing the real need in cupola practise to be brains). Ir Tr Rev —Nov. 19. 1300 w. 15 cts.

9371. The Mineral Resources of New Mexico. Thomas Tonge (A brief notice of the leading mineral-producing counties with related information). Min Jour—Nov. 14. 3000 w. 30 cts.

9385. Factors in Ore Deposition in Arizona. A. F. Wuensch (Discusses the peculiarities of the region under consideration). Min Ind & Rev—Nov. 19. 1200 w. 15 cts.

9442. The Relation of Geology to the Development of the Mineral Resources of the State. Harold W. Fairbanks (Read before the California Miners' Convention. Shows the benefits arising from the systematic investigations of geological surveys, and gives an idea of what a survey might accomplish). Min & Sci Pr—Nov. 21. 4300 w. 15 cts.

9471. Royal Mines (Explains what mines are termed royal and why). Col Guard. Nov. 20. 1000 w. 30 cts.

9473. Estimation of Sulphur in Metallurgical Products. L. Compredon (From Revue Universelle des Mines. A monograph. The result of the investigation and study of many years. The first part contains an introduction and examines the question of the selection of specimens). Col Guard. Nov. 20. Serial. 1st part. 2100 w. 30 cts.

9544. The extraction of Sulphur from Brimstone Ore. Edward F. White (The methods in use for the mechanical separation are stated, and White's apparatus for the extraction of sulphur from ore is described). Eng & Min Jour—Dec. 5. 1000 w. 15 cts.

9617. A Few Points for Prospectors. Dan De Quille (Directions for guidance in exploring new regions). Min & Sci Pr—Nov. 28. 2200 w. 15 cts.

9620. Mining in Victoria (Discusses the rapid departure of the male population and the causes, and offers suggestions to check the exodus). Min Jour—Nov. 28. 2000 w. 30 cts.

9264. Action of Water of the Hubb Coal Mine Upon Cast Iron. Frank W. Durkee (It was found that the cast iron, used for the purposes of construction within the mine, had undergone such radical changes that, while retaining their original size and shape, they could easily be broken and were no longer strong and fairly tough like cast iron. Investigations are given). Am Chem Jour—Dec. 2400 w. 45 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

9198. Commercial Testing of Gas Coal. T. Glover (Read before the Midland Assn. of Gas Managers, Eng. Advises the frequent testing of well-known coals and accurate tests of all suitable coals offered, and gives suggestions for test plant, its working and comparison of results. Discussion follows). Jour of Gas Lgts—Nov. 3. 3800 w. 30 cts.

9289. Natural Gas. J. M. Buckley (The gradual decrease of output at all points, showing that the early predictions as to the permanency of the supply were at fault, but predicting that the use of gas as a fuel will continue and a cheaper and better gas will take the place of the natural product). Pro Age—Nov 16. 1500 w. 15 cts.

9290. Comparative Test of the Calorific Powers of Wilkinson Carburetted Water Gas and Lowe Carburetted Water Gas with the Junker Calorimeter. Martin Shepard, Rudolph E. Bruckner and John Schimmel, Jr. (Graduating thesis of students of Stevens Inst. Methods of analysis are given and the plan of tests made, with results). Pro Age—Nov. 16. Serial. 1st part. 2800 w. 15 cts.

9305. A New Loomis Fuel Gas Plant (Illustrated description of the plant of the Citizens' Gas Company of Bridgeport, Conn.; the largest fuel gas plant for general service in the world). Ir Age—Nov. 19. 1200 w. 15 cts.

9368. The Residuals Market. W. E. Price (Read before the Southern District Association of Gas Engineers and Managers. A few particulars and statistics of the condition, past and present, of the market in residuals of gas works, followed by discussion). Gas Wld—Nov. 14. 5600 w. 30 cts.

9369. Regenerator Furnaces for Small Gas Works. W. B. Randall (Read before the So. Dist. Assn. of Gas Engs. & Mangrs. Describes furnaces and their workings; clinkering; effect upon residuals, &c., and is followed by discussion). Gas Wld—Nov. 14. 4800 w. 30 cts.

9407. Trials of Gas Stoves (A summary of the more important results of a number of trials of heating with gas stoves, of which reports have been published by A. von Ihering, in the "Joural fur Gasbeleuchtung"). Jour of Gas Lgt—Nov. 17. 2000 w. 30 cts.

9483. The Use of Gas for Domestic Lighting. Vivian B. Lewes (Society of Arts, Cantor Lecture. The principles of illumination and the measurement of light—illuminating value and illuminating effect—domestic lighting—flat flame, argand and regenerative burners are discussed). Pro Age—Dec. 1. 7300 w. 15 cts.

9484. Studies of the Explosive Properties of Acetylene. Messrs. Berthelot and Violle (Extracts from the proceedings of the Academie des Sciences. A study of the precise conditions under which the explosive properties were susceptible of manifesting themselves). Pro Age—Dec. 1. 2200 w. 15 cts.

9631. The New Four-Lift Holder of the New York Mutual Gaslight Company. Walter A. Allen (Description of gasholder having a capacity of 4,500,000 cubic feet). Am Gas Lgt Jour—Dec. 7. 1800 w. 15 cts.

SEWERAGE.

9466. The Purification of Sewage by Filtration. Henry Law (Read at the Sanitary Inst. Congress. The filtration of sewage when the insoluble solid matters have been removed by previous precipitation is considered). San Rec—Nov. 20. 1800 w. 30 cts.

9552. Progress Made in the Purification of the Sewage of Paris. J. F. Flagg (Descriptive account of improvements being made for the purification of all the sewage of Paris before admitting it into the Seine). Eng Rec—Dec. 5. 5000 w. 15 cts.

STREETS AND PAVEMENTS.

9501. Specifications for Repair of Asphalt Pavements (Gives the specifications for repair during the year 1896 of asphalt pavements in Buffalo). Munic Engng—Dec. 1200 w. 30 cts.

9534. Street Commissioner Waring's Tour of Observation in Europe. George E. Waring, Jr. (Part first deals with street cleaning in Vienna). Harper's Weekly—Dec. 5. Serial. 1st part. 2000 w. 15 cts.

WATER SUPPLY.

9206. An Overlooked Stand-Pipe Incident at Atlantic City, N. J. (An account of a narrow escape from destruction of a stand-pipe. The incident as related by Mr. George T. Prince and Mr. E. Graves). Eng News—Nov. 12. 1400 w. 15 cts.

9224. Filtration. S. A. Charles (A description of the filter plant at Lexington, Ky. The mechanical filter in use there is said to be entirely satisfactory). Fire & Water—Nov. 14. 2400 w. 15 cts.

9225. New York's Water Supply (Facts of interest regarding the storage capacity of the city, the amount of rainfall and the future prospects). Fire & Water—Nov. 14. 1200 w. 15 cts.

9280. The Control and Supervision of Public Water Supplies by Sanitary Authorities. C. Porter (Abstract of a paper read at the Congress of the Sanitary Institute at Newcastle-on-Tyne. Considers some of the principal powers and duties of sanitary authorities). San—Nov. 2500 w. 45 cts.

9281. Sand Filtration. Allen Hazen (Report to the Women's Health Protective Assn. concerning a practical plan for sand filtration as a means of securing a better water supply for the city of Philadelphia). San—Nov. 6000 w. 45 cts.

9417. Removal of Iron from Water from a Filter Gallery at Reading, Mass. (An outline of investigations made, with illustrated description of the process in use, which consists of the addition of milk and lime, combined with thorough aeration and rapid filtration). Eng News —Nov. 26. 4700 w. 15 cts.

9440. Meerut Water-Works (Brief account, with general plan of site). Ind Engng—Oct. 24. 800 w. 45 cts.

9453. Some Observations on the Relation of Light to the Growth of Diatoms. George C. Whipple (Presents the results of a series of experiments made during the past year with a view to determining the nature and effect of influences which relate to the growth of diatoms in lakes and ponds). Jour of New Eng Water-Works—Sept. 5000 w. 75 cts.

9454. Making Cast Iron Pipe. Jesse Garrett (The subject relates to the best means of distributing water to the community. The history of lead, wood, stone and iron pipes is briefly reviewed and illustrated. The manufacture of cast-iron pipe is described and coating discussed). Jour of New Eng Water-Works. Sept. 12000 w. 75 cts.

9455. The Financial Management of Water-Works. Freeman C. Coffin (Statistics dealing with municipal works only. The need of a consistent and generally accepted theory of management is shown and the nomenclature of water-works management is defined. Discussion follows). Jour of New Eng Water-Works—Sept. 13000 w. 75 cts.

9491. The Water Supply of Philadelphia: Considered with Reference to the Minimum Flow of the Schuylkill River. Edwin F. Smith (The conditions of the water supply are set forth with tabulated statistics bearing upon the relations existing between the maximum consumption of water and the minimum flow of the river. Followed by discussion). Pro Engs' Club, of Phila—Nov. 5500 w. 45 cts.

9531. Meerut Water-Works (A short description of the plant, with illustration). Ind Engng—Oct. 31. 600 w. 45 cts.

9611. The Danube Tunnel of the Budapest Water-Works (Der Donautunnel des Wasserwerkes von Budapest). Josef Schusfber (Explains the construction and gives the various quantities of water supplied by the various springs). Deutsche Bauzeitung. Oct. 24, 1896. 3000 w.

MISCELLANY.

9197. The Incandescent Fire-Mantel. T. E. Pye (Read before the Midland Assn. of Gas Managers, Eng. Describes an appliance designed to facilitate the combustion of non-bituminous fuel in the ordinary domestic fire grate. It claims to give a smokeless fire at about half the expense usual, and while it can be used with all fuel, it is especially adapted to gas-works coke. Also discussion). Jour of Gas Lgt—Nov. 3. 2800 w. 30 cts.

9223. Scavenging, with Special Reference to Rural Districts. George Mackay (Its importance and effect upon the health and comfort of the community, with description of system recommended). San Rec—Nov. 6. 3500 w. 30 cts.

9277. The Work of the Massachusetts State Board of Health for 1895 (A review of the year's work, which contains valuable information for hydraulic and sanitary engineers). Eng Rec—Nov. 14. 1600 w. 15 cts.

9286. What Sanitation Has Done for Life (Extracts from address of Prof. Brewer, of Yale Univ., showing that life has been prolonged, especially in cities). Safety V—Nov. 1000 w. 15 cts.

9335. Recent City Engineering in Chicago, Ill. (An account of work and costs). Eng Rec—Nov. 21. 700 w. 15 cts.

9458. The Problem of the City. Clinton Rogers Woodruff (A discussion of what good city government is in certain directions. The importance of an abundant supply of pure water, drainage, street-cleaning, transportation, &c., is presented, and examples of European cities given, with other matters of related interest). Am Mag of Civ—Nov. 3500 w. 30 cts.

9492. The Cement Laboratory of the City of Philadelphia. Its Equipment and Methods. Richard L. Humphrey (Illustrated description of laboratory for testing and inspecting the cement used in municipal work. Apparatus explained in detail, and system used.) Pro Engs' Club of Phila—Nov. 9500 w. 45 cts.

9566. Refuse Destructor at Leyton (Illustrated description of plant designed to burn unscreened town's refuse and compressed sludge). Engng—Nov. 27. 1300 w. 30 cts.

RAILROADING.

NEW CONSTRUCTION.

9154. Railroad Building and Manganese Mining in Colombia. Ill. Eduardo J. Chibas (Describing the methods and experiences of the Caribbean Manganese Co. in the Department of Panama). Eng Mag—Dec. 3000 w. 30 cts.

9208. The Great Siberian Railway (Attention is called to the importance of the undertaking, and a brief description of the project is given, with map). Eng, Lond—Nov. 6. 1800 w. 30 cts.

9240. The Glasgow Subway and Cable Traction (An illustrated description of this line, about to be opened for public traffic. It is 6 1-2 miles long, entirely under ground, and particularly interesting because of some novel methods adopted in boring the tunnels, and in view of the fact that the cable traction plant installed is one of the largest and probably the most complete yet laid down). Engng—Nov. 6. Serial. 1st part. 4000 w. 30 cts.

9247. Delagoa Bay—Pretoria Railway (Map and section, with a few particulars). Ind Engng—Oct. 10. 500 w. 45 cts.

9249. The Budapest Subway Railway. J. Kollmann (Abstract from an article in the Elektrotechnische Rundschau (Brief description of a road built for the exhibition that it seems probable will remain in use). Elect'n—Nov. 6. 1000 w. 30 cts.

9320. The Trans-Siberian Railway (The information from which this article has been prepared has been collected from Russian Government publications, U. S. Consular reports, the technical press and the proceedings of various engineering societies, and only in the case of government publications does it bear the stamp of official authority, but as a description of the broad, general features of the work it is believed to be substantially accurate). Eng News—Nov. 19. 4400 w. 15 cts.

9327. The Central London Railway. C. H. Grinling (An account of the formation of the company, with description of the road, which is to be 6 1-2 miles in length and to have 14 stations. An underground electric road). R. R. Gaz—Nov. 20. 2800 w. 15 cts.

9361. Under-Tunnelling the District Railway (Report of Sir Benjamin Baker on the proposed electric express line of railway beneath the existing Metropolitan District system). Arch, Lond—Nov. 13. 1500 w. 30 cts.

9378. A Light Railway at Eaton Hall. From the London Times (Particulars respecting a light railway recently completed in the Duke of Westminster's estate for connecting it with the Great Western Railway, three miles distant). Prac Eng—Nov. 13. 1000 w. 30 cts.

9447. The New Railway to the Derbyshire Coalfields (A few of the principal features of the project and a description of the work). Trans—Nov. 20. 4800 w. 30 cts.

9572. Lancashire, Derbyshire and East Coast Railway, and the Sheffield District Railway (Illustrated description). Eng, Lond—Nov. 27. 1300 w. 30 cts.

9619. New Harbor Railway at Bristol (Nature and extent of the proposed undertaking, with map). Trans—Nov. 27. 1000 w. 30 cts.

ELECTRIC AND STREET RAILWAYS.

9188. A Model Electric Railway Plant (Illustrated description of a very complete plant located in New Haven, Conn., and belonging to the Fairhaven and Westville R. R. Co.). Sci Am Sup—Nov. 14. 1400 w. 15 cts.

9250. A Railway Power-House Transformed (Illustrated description of the plant of the Cicero and Proviso Street Railway Co. in the western suburbs of Chicago). W Elec—Nov. 14. 600 w. 15 cts.

9270. Clontarf Electric Tramway (Illustrated description of the extension of the Dublin United Tramway Co.'s electric system). Ry Wld—Nov. 900 w. 30 cts.

9284. Compressed-Air Surface Cars in New York (Favorable comment on the trials of the system recently made in New York). Safety V—Nov. 1200 w. 15 cts.

9294. The Jungfrau Mountain Electric Railway, Switzerland (Illustrated description of the route, method of construction and operation, the electrical work, &c.). Elec Eng—Nov. 18. 1800 w. 15 cts.

9295. The Institute Discussion on Electric Traction Under Steam Railway Conditions. Dr. Charles E. Emery (The writer discusses the various phases of the subject and concludes that the application to long trunk lines does not seem practicable under present conditions). Elec Eng—Nov. 18. 3600 w. 15 cts.

9402. The Influence of Rails on Street Pavements. Edward P. North (Discusses the kinds of rails in use in various localities, their advantages and defects; also the satisfactory adjustment of the pavement to the rails, and the condition of the space between the rails). Am Soc of Civ Engs—Nov. 2200 w. $1.

9403. Car Tracks and Pavements. James Owen (Discusses the relation of the owner of the railway to the authorities in charge of the highway, and the general subject, both in city and suburbs). Am Soc of Civ Engs—Nov. 2500 w. $1.

9405. Electric Traction Under Steam Railway Conditions (Full discussions in New York and Chicago opened by Dr. Charles E. Emery). Trans Am Inst of Elec Engs—Oct. 23500 w. 45 cts.

9512. The Englewood and Chicago Storage Battery Railway (Illustrated description of a road recently put into operation). Elec Eng—Dec. 2. 1700 w. 15 cts.

9527. The Electric Railway of Varese, Italy (Brief history of the undertaking with illustrated description). St Ry Jour —Dec. 1500 w. 45 cts.

9529. Niagara Power for the Buffalo Railway System (Illustrated description of the system). St Ry Jour—Dec. 2800 w. 45 cts.

9530. A Novel Electric Railway in Fairmount Park, Philadelphia (Descriptive account). St Ry Jour—Dec. 1500 w. 45 cts.

9629. A Railway Through the Sea (Illustrated description of a novel electric railway which Mr. Magnus Volk has carried to a successful issue at Brighton, Eng.). Elec Rev, Lond—Nov. 27. 1400 w. 30 cts.

9648. Motor Cars on the Brooklyn Bridge (Illustrated description of the electrical equipment). Elec Eng—Dec. 9. 1500 w. 15 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

9161. The Standard Wheel Tread and Flange (Discussion of the suggestion of J. N. Barr at the last annual convention of the Master Car Builders, and advising the getting the rails into a proper shape rather than attempt any modification of the wheel tread. Also a letter on the subject from George S. Hodgins). RR Car Jour—Nov. 2300 w. 15 cts.

9186. A Balanced Locomotive (Illustrated description of the Strong balanced locomotive, formerly the A. G. Darwin). Sci Am—Nov. 14. 1200 w. 15 cts.

9213. Narrow Gauge and Mountain Locomotives, Bosnia and Herzegovina State Railways (Illustrated description and general information. Eng, Lond—Nov. 6. 2000 w. 30 cts.

9242. Heavy Goods Locomotive for the New South Wales Railways (Illustrated description, with principal dimensions). Engng—Nov. 6. 1000 w. 30 cts.

9269. The Barsi Light Railway Exhibition (Illustrated description of the rolling stock which was shown at Newlay. Ry Wld—Nov. 1800 w. 30 cts.

9271. Cars for Narrow-Gauge Tramways (Illustrations of a type of car specially constructed for small narrow-gauge tramways). Ry Wld—Nov. 400 w. 30 cts.

9274. The New Master Car Builders' Axle for 80,000 lb. Cars (An explanation and summary of the work of the committee which directly affected the design of the axle between wheel hubs). RR Gaz—Nov. 13. Serial. 1st part. 2000 w. 15 cts.

9282. Locomotive Boilers and Tubes (Extract from report by Ed Sauvage at the last meeting of the International Railway Congress). It is practically a condensed statement of the report). Safety V—Nov. 1000 w. 15 cts.

9329. New 60-ft. Postal Cars for the St. Louis, Iron Mountain & Southern Railway (Description and drawings). R R Gaz—Nov. 20. 500 w. 15 cts.

9414. Heavy Tank Locomotive for the Madison Incline, Pennsylvania Line (Illustrated description, with dimensions and particulars). Eng News—Nov. 26. 1700 w. 15 cts.

9488. Cast-Iron and Steel-Tired Wheels. R. C. P. Sanderson (From a paper before the Southern and Southwestern Ry Club. Briefly touches the questions of safety, weight, running qualities, rail wear and cost). Eng, Lond—Nov. 20. 2000 w. 30 cts.

9503. The First Railroad Engine (The article claims that Edward Entwistle, the man who ran it, is still living in Des Moines, Iowa. Brief account of first trip). Bos Jour of Com—Nov. 28. 1500 w. 15 cts.

9550. Three New Metallic Car Trucks (Illustrated descriptions of the Standard truck, the L. & N. freight truck, and the Buckeye truck). Ry Mas Mech—Dec. 1700 W. 15 cts.

9588. Baltimore and Ohio 60,000-Pound Box Car (Illustrated description). Loc Engng—Dec. 700 w. 30 cts.

9596. Grate for Burning Fine Anthracite Coal—Delaware, Lackawanna and Western Railroad (Illustrated description of grate for burning hard coal on engines. Designed by David Brown). Am Eng & R R Jour—Dec. 500 w. 30 cts.

MAINTENANCE OF WAY AND STRUCTURE.

9610. Changes in the Form and Position of Rails (Verande rungen in der Lage und Form des Eisenbahn gestanges). By Braunig in Kosln. (An exhaustive experimental investigation on the changes produced in the form and position for a long term of years and all conditions of weather). Zeitschrift fur Bauwesen, x-xii. 10500 w.

TERMINALS AND YARDS.

9480. Terminal Yards. H. G. Hetzler

(Shows the importance of giving attention to the arrangement so that business can be handled with the least expense and delay possible. Discusses details, and is followed by discussion). Jour W Soc of Engs—Oct. 4800 w. 45 cts.

9622. Chesapeake and Ohio Improvements. A. E. Coulter (An illustrated description of the new connections, yards and terminals at Richmond, Va.) Ry Age—Dec 4. 5000 w. 15 cts.

TRANSPORTATION.

9339. Gross and Net Railway Earnings (Returns for September and nine months of the present calendar year. Classified statements). Bradstreet's—Nov. 21 1000 w. 15 cts.

9387. American Lessons in Cheap Railroad Transport (Editorial considering the benefits to American industries arising from American railroads and the cheap transport as compared with Great Britain). Ir & Coal Trds Rev—Nov. 13. 900 w. 30 cts.

MISCELLANEOUS.

9152. High-Speed Standards of Men, Machinery and Track. H. G. Prout (Showing that the fast running of trains necessitates improvement in methods and material, and has a disciplinary effect on trainmen). Eng Mag—Dec. 3000 w. 30 cts.

9162. National Electric System of Car Lighting (Illustrated description of the system of this company, which is the result of the investigations and experiments of Mr. Morris Moskowitz). R R Car Jour—Nov. 1200 w. 15 cts.

9163. Car Lubrication. A. M. Knapp (Causes of hot box delays and suggestions for avoiding them). R R Car Jour—Nov. 1500 w. 15 cts.

9204. Reports on the Modified Routes for the New York Rapid Transit Railway (Illustrated description of the new plan, which differs from the old chiefly in comprising only those lines that are immediately necessary, and the substitution of the Elm street route for the Broadway lines between City Hall and Union Square). Eng News—Nov. 12. 5000 w. 15 cts.

9273. Rapid Transit in New York (A free abstract of the report of the chief engineer, with map and profile, and some typical sections; also editorial comment). R R Gaz—Nov. 13. 3500 w. 15 cts.

9315. Train accidents in the United States in October (Classified table with summary). R R Gaz—Nov. 20. 4500. 15 cts.

9315. On the Adoption of a Universal Standard for Rating Railway Apparatus. William Baxter, Jr. (A discussion of the subject and its importance, and the objections in the case of electric equipment. Also the fields in which standards would be of advantage). Elec Wld—Nov. 21 2200 w. 15 cts.

9328. Train Accidents in the United States in October (Classified table with summary). R R Gaz—Nov. 20. 4500 w. 15 cts.

9331. The Steam Trolley Contest in Connecticut (Editorial comment on the decision rendered by Judge G. W. Wheeler in the Superior Court of Conn.). R R Gaz—Nov. 20. 1500 w. 15 cts.

9388. Hydraulic Attachment for Raising Rotary Snow Ploughs (Illustrated description of an attachment for raising the end of the machine complete). Ry Rev—Nov. 21. 700 w. 15 cts.

9389. Liability Release Clause in Railroad Companies Ground Lease. W. L. Barnum (From a paper read at the meeting of the Grain Dealers' National Assn. A discussion of the obligations of railroad companies to grain dealers in relation to elevators for shipping grain). Ry Rev—Nov 21. 2800 w. 15 cts.

9523. Inclined Planes. Samuel Diescher. (From a paper read before the Soc of Engs of W Penna. The first part discusses types and features, compares with cable and electric roads, the balance system, safety devices, connection between engine and drum, drums and peculiar accidents). Ir Age—Dec. 3. Serial, 1st part. 3000 w. 15 cts.

9528. Piece Work in Repair Shops. C. F. Uebelacker. (States the conditions which led to the adoption of the piece-work system, how the problem of working up a price list was solved, and general details of the work. The advantages and disadvantages are cited). St Ry Jour—Dec. 3000 w. 45 cts.

9530. The Electrically Welded Continuous Rail. Richard Eyre. (The merits of the electrically welded track are shown, and the difficulties that have been conquered in bringing it to its present degree of perfection are discussed). St Ry Jour—Dec. 3300 w. 45 cts.

9538. Relative Steam-making Capacity of Firebox and Tube Surface. (Letters containing inquiry about a statement in RR Gaz to the effect that one square foot of firebox heating surface of a locomotive boiler would make as much steam as ten square feet of average tube-heating sursurface, are replied to at length, and diagrams given). RR Gaz—Dec. 4. 2700 w. 15 cts.

9539. Compressed Air in the Shops of the Union Pacific Railroad at Omaha. H. N. Latey. (Illustrated description of what the writer considers an ideal system). RR Gaz—Dec. 4. 2000 w. 15 cts.

BOOKS OF THE MONTH

BOOK NOTICES.

STURGIS, RUSSELL. EUROPEAN ARCHITECTURE. A Historical Study. The Macmillan Co., New York, 1896. Cloth, $4.

The monuments of architectural art are herein made the subject of minute personal study by a critical writer of authoritative standing in the architectural profession. Documents are referred to only for verification of dates, or for the procuring of data once recorded, but no longer available through the decay and dilapidation of structures. Some such structures have so far perished that they can be reconstructed only by mental processes. The history begins with the sixth century before Christ, and is brought down to the time of the French revolution. The work contains nine chapters, the later ones dealing with architecture in France, Germany, and Italy.

LONERGAN, WALTER F. HISTORIC CHURCHES OF PARIS. With Drawings by Brinsley S. Le Fanu, and from Photographs. T. Whittaker, New York, 1896. Cloth, $6.

Twenty-four churches are described: —Notre Dame, Sainte Chapelle, and St. Denis in an extended way proportional to their historical interest. There are some fifty illustrations of the churches and their contents. While the architectural features are not neglected, the historical features are given more prominence. One of the most valuable parts of the book is an index of authors who have written of these churches and their various attractions, architectural and otherwise.

PIERCE AND RICHARDSON, ELECTRICAL ENGINEERS. The National Electrical Code. Charles A. Hewitt, Chicago 1896. Flexible morocco, pocket-book style. $2.

A successful attempt to present such an analysis of the underwriters' National Electrical Code as will be intelligible to non-experts. It is a reprint of articles originally published in the *Insurance Post* of Chicago, in response to many requests. A full table of contents is given, but a thorough index, which is lacking, would have added very much to the convenience and value of the book.

HOWE, MALVERD A. RETAINING WALLS FOR EARTH. Third edition, revised and enlarged. John Wiley & Sons, New York, 1896. Cloth, $1.25.

Includes the theory of earth-pressure as developed from the ellipse of stress. Also contains a short treatise on foundations, illustrated with examples from practice. The latter replaces the appendix of the second edition. The demonstrations have been made shorter by basing them upon the theory of the ellipse of stress advanced by Prof. Rankine in 1858, instead of retaining those of Prof. Weyrauch employed in the first edition. The latter are presented in an appendix to the present edition, and the results of the shorter method are thus shown to be identical with those obtained by Weyrauch. The labor of substitution in the formulæ has been much lessened by computation and tabulation of coefficients.

MARQUAND, ALLAN, AND FROTHINGHAM, ARTHUR L., JR. A Text-book of the History of Sculpture. Longmans, Green & Co., New York. 1896. Cloth.

THE third of the series of college histories of art, edited by John C. Van Dyke, professor of the history of art in Rutgers College, and published by this house. The book forms a fitting sequel to the "History of Painting," by Prof. Van Dyke, and the "History of Architecture," by Prof. Alfred D. F. Hamlin of Columbia University, which have preceded it. The authors, in the preface, give as a reason for not including prehistoric sculpture in the scope of a work intended for students in schools and colleges that the want of connection of that sculpture "with the flow of civilization is at present too remote and ill defined." Saracenic, Indian, Chinese, and Japanese sculpture are also excluded, as being, "from a historical standpoint, in great measure still a mystery to the western world." The work is planned as an aid to the study of sculpture through casts and photographs; and lists of addresses for photographs and casts, respectively, are presented. The history begins with Egyptian sculpture, and proceeds through Babylonian, Assyrian, Persian, Hittite, Phœnician, and Cypriote sculpture to the Greek, two chapters being assigned to Egyptian, and one to each of the others. Four chapters are assigned to Greek sculpture, one to Italian and Etruscan, and one to Roman. Early Christian and Byzantine sculpture are dealt with in a single chapter. Three chapters are devoted to medieval sculpture,—Italy, France, and Germany having each a chapter. Four chapters are taken up with the history of renaissance sculpture in Italy (1500 A. D. to 1800 A. D.), one chapter with renaissance sculpture in France, and one with renaissance sculpture in Germany, The Netherlands, Spain, and England. Four chapters are then devoted to modern sculpture in Italy, Denmark, Sweden, Germany, Russia, France, England, and the United States. This enumeration sufficiently displays the method of the book, in respect of classification; but there is also a further sub-division into periods of art. With the history of each of the classes of sculpture named there is given a valuable list of books recommended for reading. The book is handsomely printed on coated paper, and the illustrations are numerous and excellent.

WILLIAM, JASPER NICOLLS. THE STORY OF AMERICAN Coals. J. B. Lippincott Co., Philadelphia. 1896. Cloth.

THE author has here successfully brought together a mass of information which hitherto could be found only in scattered books, some of which are out of print. American coals only are treated. The author is a mining engineer of fifteen years' experience in Pennsylvanian coal-fields. Part I of the book contains, under the general division of the origin of American coals, eight chapters. Part II treats of the development of the mines, in eight chapters. Part III deals with the subject of transportation, also in eight chapters, and nine chapters in Part IV are concerned with the subject of consumption. The treatise is singularly free from technicalities, and is written in popular style without much sacrifice either of accuracy of statement, or conciseness. Any lay reader interested in the industries of the country may peruse the work with pleasure and profit.

WESTON, EDMUND B. TABLES SHOWING LOSS OF Head due to Friction of Water in Pipes. D. Van Nostrand Co. New York. 1896. Flexible morocco; pocket-book form. $2.

The tables show (1) the loss of head due to friction of water in pipes having very smooth interior sides (*e. g.*, pipes of lead and brass), and (2) loss of head due to friction in pipes of rough interior,—for example, new cast-iron pipes. Description of the tables, examples, and supplementary tables are supplied. The latter give (1) theoretical velocities for use in obtaining results beyond the highest limits of table No. 1; (2) theoretical velocities for use in obtaining results beyond the highest limit of table No. 2; and (3) constants for different diameters to be used for extending table No. 2, and in obtaining results beyond the highest limits of that table. The tables are printed in clear, bold type, and are very handy for practical use.

ROBINSON, STILLMAN W. PRINCIPLES OF MECHANISM. A Treatise on the Modification of Motion by Means of the Elementary Combinations of Mechanism, or of the Parts of Machines. First edition. John Wiley & Sons, New York. 1896.

An important addition to the literature of mechanical engineering, intended for the use of colleges and mechanical engineers, who will find in it, not a historical treatise, but a thorough discussion of the underlying principles of mechanism for transmitting and changing the direction and velocity of motion. A machine is defined at the outset as "a combination of fixed and moving parts or devices, so disposed and connected as to transmit or modify force and motion for securing some useful result." The fixed parts are regarded as a class, separate from the moving parts. The moving parts are categorically classified as revolving shafts; revolving wheels (with or without teeth); rods or bars with reciprocatory or vibratory motion, or both; flexible connectors depending on friction; flexible connectors independent of friction; and a column of fluid in a pipe. Very likely this classification may be deemed imperfect by some critics, and not sufficiently comprehensive by others; but in his derivation of trains of mechanism upon the basis of the classification the author has succeeded in very plainly elucidating principles, and has elaborated a good and useful book, which the publishers have printed, illustrated, and bound in their usual fine style of printing.

RAYMOND, WILLIAM G. A TEXT-BOOK OF PLANE SURVEYING. American Book Co., New York. 1896. Cloth. $3.

A manual for the study and practice of surveying, in which the long experience and practice of the author in the field has been combined with a similarly prolonged experience in the class-room as an instructor in one of the best technical schools in the land. Modern methods, clear and concise statements, and definite directions are features which even the most cursory examination discloses. The book is unusually well illustrated for a treatise of the kind. The tables are printed on tinted paper, which distinguishes them from the rest of the work and facilitates reference.

The logarithmic tables are carried out to five places of decimals, and the type and paging are so arranged that all numbers beginning with a given figure can be found without turning the page. The arrangement of tables, of sines, cosines, etc., is for tenths of a minute, instead of for seconds,—a method regarded as more serviceable both for practical and theoretical use. Another feature is that of colored maps finished as in actual practice. Altogether a good and carefully-prepared book.

BOOKS ANNOUNCED.

Gardenier, Norman. Ready Help for Locomotive Engineers and Firemen. D. McKay, Philadelphia. 1896. Cloth, $1.

Roper, Stephen. Care and Management of the Steam Boiler. New Issue. D. McKay, Philadelphia. 1896. Morocco, $2.

Roper, Stephen. Catechism of High Pressure Steam Engines. New issue. D. McKay, Philadelphia, 1896. Morocco, $2.

Roper, Stephen. Engineers' Handy-book. New issue. D. McKay, Philadelphia. 1896. Morocco, $3 50.

Roper, Stephen. Handbook of Land and Marine Steam Engines. New issue. D. McKay, Philadelphia. 1896. Morocco, $3.50.

Roper, Stephen. Handbook of the Locomotive. New issue. D. McKay, Philadelphia. 1896. Morocco, $2.50.

Roper, Stephen. Handbook of Modern Fire Engines. New issue. D. McKay, Philadelphia. 1896. Morocco, $3.50.

Roper, Stephen. Instructions and Suggestions for Engineers and Firemen. New issue. D. McKay, Philadelphia. Morocco, $2.

Roper, Stephen. Questions and Answers for Engineers. New issue. D. McKay, Philadelphia. 1896. Morocco, $3.

BOOKS RECEIVED.

Fowler, William H., Editor. Practical Engineer Pocket-Book for 1897. Technical Publishing Company, L't'd., Manchester, England. 1896. Leather, gilt with diary on ruled section paper, post free, 1s. 8d.; cloth, without diary, post free, 1s. 2d.

Hogg, Prof. Alex., M.A. Special Edition Revised and Enlarged. With New Illustrations. Prof. Alex. Hogg, Superintendent of Schools, Fort Worth, Texas. 1897. Paper.

Converse, John H., A.B. Citizenship and Technical Education. Address delivered on Founder's Day (October 8, 1896). John H. Converse, Philadelphia. 1896. Paper.

Hild, William R. Seventh Annual Report of the Syracuse water board to the mayor of the city of Syracuse, for the year ending June 30, 1896. Paper.

Department of Crown Lands, Toronto. Fifth Report of the Bureau of Mines. Maps, geologically colored and compiled from plans of survey by the department of crown lands, and plans of survey by the geological survey department, Ottawa, exhibiting parts of the Rainy River district near Rainy Lake, and River Seine, and of the country in the vicinity of Manitou, Wabigoon, and Eagle Lakes.

Vogdes, Anthony W., Capt. Fifth Artillery, U.S.A. A Bibliography relating to the geology, paleontology, and mineral resources of California. Bulletin No. 10 of the California State mining bureau. J. J. Crawford, State Mineralogist, San Francisco. 1896.

Behr, Hans C., Mechanical Engineer. Mine Drainage, Pumps, etc. Bulletin No. 9, California State mining bureau. J. J. Crawford, State Mineralogist, San Francisco. 1896.

Tenth Annual Report of the Commissioner of Labor. 1894. Strikes and Lockouts, Volume II., Summaries of Strikes and Lockouts. Government Printing Office, Washington, D.C. 1896.

Fifth Report of the Bureau of Mines. 1895. Printed by order of the Legislative Assembly of Ontario. Warwick Bros. and Rutter, Printers, Toronto. 1896.

Twenty-Seventh Annual Report of the State Board of Health of Massachusetts. Public document No. 34. Cloth, 807 pp.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

R. D. Wood & Co. Philadelphia, Pa., U.S.A. =Pamphlet illustrating and describing the Taylor gas producer, gas fuel, and the application of producer gas to manufacturing purposes.

The Waterbury Farrel Foundry and Machine Co. Waterbury, Conn., U.S.A.=(*a*) Leaflet containing Index of 1897 Catalogue. (*b*) Pamphlet containing illustrations of newly-designed machines used in the manufacture of sheet-metal goods. (*c*) Leaflet illustrating and briefly describing five styles of tube-and rod-drawing machinery.

Michigan Mining School, Houghton, Mich.= Catalogue for 1894–1896, with statements concerning the institution and its courses of instruction, which comprise an eclectic system claimed to be different from any other technical school.

The Bristol Company, Waterbury, Conn.= Circular illustrating and describing a partial list of the Bristol recording instruments for pressure, temperature, and electricity.

Ross and Co. London, Eng.=(*a*) Catalogue and price-list of telescopes and binocular glasses. (*b*) Pamphlet illustrating and describing new photographic lenses for 1896. (*c*) Pamphlet illustrating and describing the Ross new patent Science Lantern arranged for use vertically, or for parallel beam work.

Robert Poole and Son Co., Baltimore, Md., U.S.A.=New gearing list. Larger and more complete than heretofore issued. Includes both machine-moulded gears, and cut gears of all kinds, from the smallest up to fifty feet in diameter.

School of Mining and Agriculture, Kingston, Ontario.=Calendar of the fourth session, 1896–1897.

The Cutter Electrical and Mfg. Co., Philadelphia, Pa., U.S.A.=Engineers' Edition of Catalogue and Data Book of the "I. T. E." (inverse, time element) automatic circuit breaker for various purposes and for both direct and alternating current circuits.

Betts Machine Co., Wilmington, Delaware, U.S.A.=(*a*) Illustrated pamphlet describing planing machines of different sizes and styles. (*b*) Pamphlet illustrating and describing boring and turning mills.

Colorado Iron Works Co., Denver, Colorado, U.S.A.=Pamphlet illustrating and describing ore-crushing machinery, for concentration, amalgamation, cyanide, chlorination and smelting plants, and other mining, milling, and smelting equipment.

P. Blaisdell & Co., Worcester, Mass., U.S.A. =Catalogue (1896) of Machinists' Tools, illustrating and describing patent upright drills with quick return, engine lathes, planers, boring mills, gear cutters, and hand-lathes.

J. T. Slocomb & Co., Providence. R. I., U.S.A.=Catalogue (1896) and price-list of Machinists' Tools, such as callipers, gages, micrometer gages, indicators, center drills, etc , etc.

Ranken & Fritsch Foundry and Machine Co., St. Louis, Mo., U.S.A.=Pamphlet illustrating and describing the Ranken-Fritsch Corliss Engines, and their details.

Morse, Williams & Co., Philadelphia, Pa., U.S.A.=Portfolio of plates with descriptive text of hydraulic, electric, steam belt, and hand-power elevators, dumb waiters, and general hoisting machinery.

U. Baird Machinery Company, Pittsburg, Pa., U.S.A.=Catalogue *B*, a large illustrated quarto of 656, 9″×12″, pages, bound in stiff buckram cover. Illustrated descriptions and price-lists of very extensive and comprehensive lines of iron and wood-working machinery, machinists, supplies, etc.

I. P. Frink, New York.=Catalogue No. 26. Frink's patent reflectors for electric, gas, combination, and Welsbach lights.

Clayton Air Compressor Works, New York, U. S. A.=Circular supplementing Catalogue No. 8. The catalogue and the supplementary circular together include a long line of compressed-air tools and appliances, comprising in their illustrated descriptions all prominent and important compressed-air machines and devices, thus thoroughly and comprehensively representing the development of a mode of transmitting power now rapidly coming to the front as a rival to electrical transmission.

The Link-Belt Engineering Co. (Nicetown), Philadelphia, Pa., U. S. A.=" Modern Methods," an octavo volume of 130 pages illustrating and describing the capabilities of the machinery for handling materials made by the firm, with cuts and price lists.

The Trenton Iron Co.,Trenton, N. J.: Cooper Hewitt & Co., New York.=Volume of 164 pages illustrating and describing wire rope transportation in all its branches, including the "Bleichet," "Roe," and "Acme" patent systems, patent hoist conveyors for quarries, dam-building, open cut work, etc., and wire-rope outfits for shafts, inclined planes, power transmissions, etc.

Lehigh University. South Bethlehem, Pa., U. S. A.=(*a*) Pamphlet describing the course, in civil engineering, including history and plan ; program of studies, drawing, surveying, construction and materials, sanitary and hydraulic engineering, bridge engineering, etc. (*b*) Pamphlet describing course in mechanical engineering. (*c*) Pamphlet describing courses of study in department of English language and literature, preparation required for admission, etc. (*d*) Pamphlet describing school of general literature—three courses—classical, Latin, scientific, and course in science and letters.

Massachusetts Institute of Technology, Boston, Mass. Pamphlet describing the course in mining engineering, and in metallurgy.

Fairbanks, Morse & Co., Chicago, Ill., U.S.A. = Pamphlet illustrating and describing the Fairbanks-Morse Gas and Gasolene Engines.

The Pope Tube Company, Hartford, Conn., U.S A = Illustrated pamphlet, describing the process and methods of steel tube making as conducted in this establishment, its facilities, and the qualities of the high class tubing made therein.

Rudolph & Krummel Machine Works, Chicago, Ill., U.S.A. = Catalogue of presses, dies, sheet-metal. and wire-working machinery, and special machinery for manufacturing bicycles.

Chas. J. Bogue, New York, N. Y., U.S.A. = Illustrated catalogue and price-list of American dynamos and lamp-parts for the "American" system of dynamos and arc lamps.

A A. Griffing Iron Company, New York, N. Y., U.S.A. = Large illustrated pamphlet describing the "Bundy Sectional Tubular Heater."

The Colorado Iron Works Co., Denver, Colo., U.S.A. = Pamphlet entitled "Some Details as to Smelting Practice and Equipments for the Reduction of Gold, Silver, Lead, and Copper Ores."

The Connecticut Telephone and Electric Co., Meriden, Conn., U.S.A. = Catalogue and price-list of telephones, telephone equipment, and electrical supplies.

The Lehigh University, South Bethlehem, Pa. = Pamphlet describing courses of study in mining and metallurgy, stating the requirements for admission, and giving other information relating to adjunct technical engineering studies, etc.

A. A. Griffing Iron Company, New York, N. Y., U.S.A. = Pamphlet illustrating and describing the construction and operation of the "Bundy" return steam traps, tank traps, trap check valves, and trap receivers.

Thayer School of Civil Engineering, Dartmouth College. = Catalogue and price-list of books used in the schedules of the courses of instruction. Publishers' addresses are given. Titles of books considered indispensable to engineers, printed in small capitals. Books of special value indicated by an asterisk.

The Westinghouse Machine Company, Pittsburg, Pa., U.S.A. = (*a*) Beautifully illustrated pamphlet describing the "Westinghouse" steam engines with pictures of installations, testimonials, etc. (*b*) Similar pamphlet illustrating and describing the "Westinghouse" gas engines.

The Baker Gun and Forging Co., Batavia, N. Y. = "The Baker Gun Quarterly." An illustrated newspaper devoted to the description of several fine shot-guns which the company have just introduced. The firm makes a business of dealing directly with the users of their guns, and has issued the newspaper quarterly as a means of keeping in touch with patrons and replying to all general correspondence from sportsmen. A very useful paper.

Cahall Sales Department, Bank of Commerce Building, Pittsburg, Pa. = A very handsomely printed pamphlet giving six full-page views, with detailed description, of the Cahall vertical and the Babcock & Wilcox horizontal water-tube boilers manufactured by the Aultman & Taylor Machinery Co., Mansfield, Ohio.

American Blower Co., Detroit, Mich. = An elaborately illustrated and beautifully-printed catalogue of 210 pages, giving every possible detail of information with regard to the modern apparatus for heating, ventilating, and drying manufactured by this firm. It is one of the finest specimens of the printers' art ever issued; printed in three colors throughout; the very numerous engravings are made by Conant, and are exceptionally fine; the entire work is divided into 13 parts, each of which is readily accessible; and a great variety of new matter of interest to heating engineers, architects, and contractors is presented. A very valuable work. Sent free on application.

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THE EARLY PROMISE OF AMERICAN MARITIME POWER.

By Alexis de Tocqueville.

THE building of the new United States navy; the rapid development of our ship-building industry, particularly on the Great Lakes; the increasing volume and variety of our export trade; and the astonishing spread of popular interest in yacht-racing and nautical sports of all kinds, these are broad facts which show clearly enough that the American people are rousing themselves to a livelier interest in shipping affairs, and that we have undoubtedly entered upon a new era in the development of our maritime interests.

For thirty years past the American people have been engrossed in the development of our great west, in the building of new cities and towns, and in the construction of our vast railroad systems. As a rule, therefore, Americans of the present generation know nothing and have heard little of shipping interests. They have had neither taste or time for it, because other fields of activity were more promising and more profitable. To most of our readers, therefore, it may seem like romance to talk of those times in the past when American shipping was our pride and boast, and when we challenged England's leadership in the carrying-trade of the world. But the sounding statement is sustained by the sober facts, and happily we are able to present disinterested corroborative testimony of so high authority that it cannot be questioned.

Alexis de Tocqueville enjoys just and enduring fame as one of the greatest critical and philosophical writers of all time. In his celebrated work "Democracy in America" the great Frenchman devoted a chapter to describing American shipping as he saw it sixty years ago, and it is from these pages that the following significant extracts are taken. They come as a fitting sequel to Mr. Nixon's interesting and forcibly-written paper in our last number, because the facts show that, without orders for war-ships, without subsidies from the government, and in spite of the higher cost of operating American ships, we yet built up a carrying-trade in American bottoms which challenged the admiration of the world—precisely as we have done in recent years on the Great Lakes. We do not underestimate the value to shipping interests of the government's orders for war-ships, and we have gladly opened our pages to a presentation of the subject from the ship-builder's point of view. But we pin our faith to individual enterprise, to the inventive genius and the capacity for business which our people have shown; and, with or without orders for war-ships, we look for a continuous and rapid expansion of our ship-building industry and our shipping interests. The United States has become the world's center for the cheap production of iron and steel. That fact of itself will ultimately give us "the paramount control of the commerce of the world," as Mr. Atkinson has so confidently predicted.—THE EDITOR.

The coast of the United States from the bay of Fundy to the Sabine river in the gulf of Mexico is more than two thousand miles in extent. These shores form an unbroken line, and they are all subject to the same government. No nation in the world possesses vaster, deeper, or more secure ports for shipping than the American.

The inhabitants of the United States constitute a great civilized people, which fortune has placed in the midst of an uncultivated country, at a distance of three thousand miles from the central point of civilization. America consequently stands in daily need of European trade. The Americans will, no doubt, ultimately succeed in producing or manufacturing at home most of the articles which they require; but the two continents can never be independent of each other, so numerous are the natural ties which exist between their wants, their ideas, their habits, and their manners.

The union produces peculiar commodities which are now become necessary to us, but which cannot be cultivated, or can only be raised at an enormous expense, upon the soil of Europe. The Americans only consume a small portion of this produce, and they are willing to sell us the rest. Europe is, therefore, the market of America, as America is the market of Europe; and maritime commerce is no less necessary to enable the inhabitants of the United States to transport their raw materials to the ports of Europe than it is to enable us to supply them with our manufactured produce. The United States were, therefore, necessarily reduced to the alternative of increasing the business of other maritime nations to a great extent, if they had themselves declined to enter into commerce, as the Spaniards of Mexico have hitherto done ; or, in the second place, of becoming one of the first trading-powers of the globe.

The Anglo-Americans have always displayed a very decided taste for the sea. The declaration of independence broke the commercial restrictions which united them to England, and gave a fresh and powerful stimulus to their maritime genius. Ever since that time the shipping of the union has increased in almost the same rapid proportion as the number of its inhabitants. The Americans themselves now transport to their own shores nine-tenths of the European produce which they consume. And they also bring three-quarters of the exports of the new world to the European consumer. The ships of the United States fill the docks of Havre and of Liverpool, while the number of English and French vessels which are to be seen at New York is comparatively small.

Thus not only does the American merchant face competition in his own country, but he even supports that of foreign nations in their own ports with success. This is readily explained by the fact that the vessels of the United States can cross the seas at a cheaper rate than any other vessels in the world. As long as the mercantile shipping of the United States preserves this superiority, it will not only retain what it has acquired, but it will constantly increase in prosperity.

It is difficult to say for what reason the Americans can trade at a lower rate than other nations, and one is at first led to attribute this circumstance to the physical or natural advantages which are within their reach ; but this supposition is erroneous. The American vessels cost almost as much to build as our own ; they are not better built, and they generally last for a shorter time. The pay of the American sailor is more considerable than the pay on board European ships,—which is proved by the great number of Europeans who are to be met with in the merchant vessels of the United States. But I am of opinion that the true cause of their superiority must not be sought for in physical advantages, but that it is wholly attributable to their moral and intellectual qualities.

The following comparison will illustrate my meaning. During the campaign of the revolution the French introduced a new system of tactics into the art of war, which perplexed the oldest generals and very nearly destroyed the most ancient monarchies in Europe. They undertook (which had never before been attempted) to make shift without a number of things which had always been held indispensable in warfare ; they required novel exertions on the part of their troops, which no civilized nations had ever thought of; they achieved great actions in an incredibly short space of time; and they risked human life without hesitation to obtain the object in view. The French had less money and fewer men than their enemies; their resources were infinitely inferior; nevertheless, they were constantly victorious, until their adversaries chose to imitate their example.

The Americans have introduced a similar system into their commercial speculations; and they do for cheapness what the French did for conquest. The European sailor navigates with prudence; he only sets sail when the weather is favorable; if an unseen accident befalls him, he puts into port; at night he furls a portion of his canvas; and, when the whitening billows intimate the vicinity of land, he checks his way, and takes an observation of the sun. But the American neglects these precautions and braves these dangers. He weighs anchor in the midst of tempestuous gales; by night and by day he spreads his sails to the wind; he repairs as he goes along such damages as his vessel may have sustained from the storm; and, when he at last approaches the term of his voyage, he darts onward to the shore as if he already descried a port. The Americans are often shipwrecked, but no trader crosses the seas so rapidly. And, as they perform the same distance in a shorter time, they can perform it at a cheaper rate.

The European touches several times at different ports in the course of a long voyage; he loses a good deal of precious time in making the harbor, or in waiting for a favorable wind to leave it; and he pays daily dues to be allowed to remain there. The American starts from Boston to go to purchase tea in China; he arrives at Canton, stays there a few days, and then returns. In less than two years he has sailed as far as the entire circumference of the globe, and he has seen land but once. It is true that during a voyage of eight or ten months he has drunk brackish water, and lived on salt meat; that he has been in a continual contest with the sea, with disease, and with the tedium of monotony; but, upon his return, he can sell a pound of his tea for a half-penny less than the English merchant, and his purpose is accomplished.

I cannot better explain my meaning than by saying that the Americans affect a sort of heroism in their manner of trading. But the European merchant will always find it very difficult to imitate his American competitor, who, in adopting the system which I have just described, follows, not only a calculation of his gain, but an impulse of his nature.

The inhabitants of the United States are never fettered by the axioms of their profession; they escape from all the prejudices of their present station; they are not more attached to one line of operation than to another; they are not more prone to employ an old method than a new one; they have no rooted habits, and they easily shake off the influence which the habits of other nations might exercise upon their minds, from a conviction that their country is unlike any other, and that its situation is without a precedent in the world.

This perpetual change which goes on in the United States, these frequent vicissitudes of fortune, accompanied by such unforeseen fluctuations in private and in public wealth, serve to keep the minds of the citizens in a perpetual state of feverish agitation, which admirably invigorates their exertions and keeps them in a state of excitement above the ordinary level of mankind. The whole life of an American is passed like a game of chance, a revolutionary crisis, or a battle. As the causes are continually in operation throughout the country, they ultimately impart an irresistible impulse to the national character. The American, taken as a chance specimen of his countrymen, must, then, be a man of singular warmth in his desires, enterprising, fond of adventure, and, above all, of innovation. The same bent is manifest in all that he does; he introduces it into his political laws, his religious documents, his theories of social economy, and his domestic occupations; he bears it with him in the depth of the backwoods, as well as in the business of the city. It is the same passion, applied to maritime commerce, which makes him the cheapest and the quickest trader in the world.

As long as the sailors of the United States retain these inspiriting advantages, and the practical superiority which they derive from them, they will not only continue to supply the wants of the producers and consumers of their own country, but they will tend more and more to become, like the English, the factors of all other peoples. This prediction has already begun to be realized; we perceive that the American traders are introducing themselves as intermediate agents in the commerce of several European nations; and America will offer a still wider field to their enterprise.

It is unquestionable that the Americans of the north will one day supply the wants of the Americans of the south. Nature has placed them in contiguity, and has furnished the former with every means of knowing and appreciating those demands, of establishing a permanent connection with those States, and of gradually filling their markets. The merchant of the United States could only forfeit these natural advantages if he were very inferior to the merchant of Europe, to whom he is, on the contrary, superior in several respects. The Americans of the United States already exercise a very considerable moral influence upon all the peoples of the new world. They are the source of intelligence, and all the nations which inhabit the same continent are already accustomed to consider them as the most enlightened, the most powerful, and the most wealthy members of the great American family. All eyes are, therefore, turned toward the union; and the States of which that body is composed are the models which the other communities try to imitate to the best of their power: it is from the United States that they borrow their political principles and their laws.

The Americans of the United States stand in precisely the same position with regard to the peoples of South America as their fathers, the English, occupy with regard to the Italians, the Spaniards, the Portuguese, and all those nations of Europe which receive their articles of daily consumption from England, because they are less advanced in civilization and trade. England is at this time the natural emporium of almost all the nations which are within its reach; the American union will perform the same part in the other hemisphere; and every community which is founded, or which prospers, in the new world is founded and prospers to the advantage of the Anglo-Americans.

If the union were to be dissolved, the commerce of the States which now compose it would undoubtedly be checked for a time; but this consequence would be less perceptible than is generally supposed. It is evident that, whatever may happen, the commercial States will remain united. They are all contiguous to each other; they have identically the same opinions, interests, and manners; and they are alone competent to form a very great maritime power. Even if the south of the union were to become independent of the north, it would still require the service of those States. I have already observed that the South is not a commercial country, and nothing intimates that it is likely to become so. The Americans of the south of the United States will, therefore, be obliged, for a long time to come, to have recourse to strangers to export their produce, and to supply them with the commodities which are requisite to satisfy their wants. But the northern States are undoubtedly able to act as their intermediate agents cheaper than any other merchants. They will, therefore, retain that employment, for cheapness is the sovereign law of commerce. National claims and national prejudices cannot resist the influence of cheapness.

Nations, as well as men, almost always betray the most prominent features of their future destiny in their earliest years. When I contemplate the ardor with which the Anglo-Americans prosecute commercial enterprise, the advantages which befriend them, and the success of their undertakings, I cannot refrain from believing that they will one day become the first maritime power of the globe. They are born to rule the seas, as the Romans were to conquer the world.

STANDARDIZING THE TESTING OF IRON AND STEEL.

By P. Kreuzpointner.

AMID the lavish praises of the civilizing influences of steam and electricity, it is well not to forget the merits of the vehicles by the aid of which we are enabled to make these civilizing agencies practically useful for every-day life. Iron and steel being the transmitters and conveyers of electricity and the expansive force of steam, these metals may be considered the foundation, upon which the superstructure of our intellectual and material life rests and moves.

What is it in the nature of iron and steel that enables these metals to perform the herculéan task of carrying the world's commerce and industry, and to meet and ward off successfully the impetuous onslaught of sudden impact as well as the invisible, but none the less active, forces of measureless strains, which gradually weaken and undermine the strength and soundness of these metals? Indeed, endless are the disguises under which the enemies of iron and steel try to cause a break or a wreck. And since, however stubborn the resistance, wear will eventually cause the breakdown of the strongest structure, a cloud of invisible particles of iron and steel is strewn along their paths to the grave.

Considering the ever-active forces at work to destroy metals, and the ever-present necessity of reducing cost, the engineer has a continual battle with the problem of so building his structure as to secure the greatest safety and durability and consume the least metal. Familiarity with the qualities of iron and steel is, to both engineer and manufacturer, a question of the survival of the fittest.

When inquiring into the serviceableness of iron and steel for structural purposes, it is well to free our mind from the idea that these metals are rigid, immovable bodies with a power of resistance that does not change until they are worn out or break under an overwhelming force. Contrary to the popular theory, iron and steel are sensitive, susceptible to outside impressions,—sometimes giving way readily to the influence of gentle persuasion. The fact is that all metals, even the hardest steel, are plastic and elastic, their plasticity and elasticity differing only in degree, not in kind. In other words, iron and steel flow like viscous bodies, under the application of sufficient time and pressure, or heat,—some grades more quickly than others. Nor does it take very great pressure to set even hard steel in motion. If, however, a not too great pressure be taken off before any permanent distortion has taken place, the metal will return to its original shape or dimensions, and, according to the greater or less degree in which a metal does this, the more or less it is elastic. This difference in the elasticity of iron and steel is again, like plasticity, one of degree only, not of kind, though, the greater the degree of plasticity of a grade of iron and steel, the less the pressure necessary to make it flow, the less the degree of elasticity. The elasticity of iron and steel decides their value for a given purpose, and the engineer who knows best how to make use of that property and the best method of ascertaining its degree will, other things being equal, build the safest and most durable structure, because it has been proved that, as long as a structure is not strained beyond the elastic limit, it is practically indestructible.

Iron and steel are very much averse to having their virtues pried into and measured by thumb-rule. They must be approached with the delicacy that we show in approaching a high-bred, sensitive person.

That this is no mere figure of speech may be strikingly shown by an instance that came under the personal observation of the writer. At one time he was testing a bar of spring steel 1 inch wide, 3/8 inch thick, and 20 inches long, with a tensile strength of 110,000 pounds per square inch. To ascertain the elastic limit, suitable micrometers measuring to the ten-thousandth part of an inch had been attached to the ends of the test-piece with wires leading to an electric bell and so causing it to ring whenever the points of the micrometers came in contact. When the piece was stretched, however slightly, contact was broken, and the bell ceased to ring. The number of revolutions of the screw necessary to renew contact indicated the amount of stretch for a given load. Just at the beginning, the test was stopped. Some visitors coming in, one of them explained how test-pieces are pulled apart, and, in the course of his explanation, picked up the spring-steel test-piece and pulled at the ends with both hands to indicate the action of the testing-machine. Thereupon the electric bell ceased to ring. The gentleman had stretched or bent the piece sufficiently to break the contact. It seemed incredible that any person could stretch a piece of spring steel 1 inch wide and 3/8 inch thick with his hands. But there was no doubt about it. It was tried again and again by various persons, and the experiment succeeded almost every time. Now, if a man can stretch or bend a piece of spring-steel with his hands, what must be the effects of heavy loads?

And yet there are not a few persons, with knowledge and without knowledge, who denounce testing as a superfluous refinement of some cranky engineer, or who admit testing only as a sort of necessary evil, to be executed by any method or no method, as fancy may dictate.

With Bauschinger's celebrated mirror apparatus, it is possible to measure stretch to the $\frac{1}{25000}$ part of a millimeter, and it has been found that, even with the small loads necessary to stretch a piece of steel to that trifling extent, there is still a permanent set taking place. In other words, there is, theoretically, no elastic limit. In practical engineering, however, these small stretches are not taken into consideration, and it has been agreed to call the elastic limit that point where the stretch begins to increase faster than the load.

For instance, if the load applied is 10,000 pounds, and the stretch is $\frac{1}{1000}$ of an inch, stretch and load are still proportional to each other, and the elastic limit has not yet been reached. But, if the load is 11,000 pounds and the stretch is now $\frac{13}{10000}$ of an inch, load and stretch have become disproportional, and the elastic limit is supposed to have been reached. In every-day practice, however, we have to deal not only with this comparatively simple question of ascertaining the quality of a given metal, or grade of metal, but with the processes of melting, heating, rolling, and cooling, which introduce a multiplicity of variations in quality of greater or less influence on its durability for a given purpose, and therefore more or less complicate the work ascertaining its reliability.

So far I have attempted briefly to show that iron and steel are not the rigid, immovable, uniform bodies that many suppose them to be. As a consequence of this plasticity, it has become imperative, on account of the ever-widening circle of application, to carefully ascertain the suitability of the various grades of steel for various purposes.

It is well known that this is done by pulling, twisting, bending, nicking, punching, etc. It does not seems to be so well known, though, that not every method is suitable. In the absence of an agreement as to the best method, much time and money are spent with no other effect than that of needlessly increasing cost of production. Economic conditions have imposed upon us the necessity of adopting uniform methods in commercial transactions and industrial pursuits.

We have uniform measures of quantity; why not also uniform measure of quality of metals? The yard or meter, pound or kilogram, quart or liter, are the same everywhere. But the quality of a ton of steel is determined chiefly by the more or less fragmentary knowledge the engineer or consumer may happen to possess of the properties of steel, or, in some instances, by mere opinion and fancy. If we add to this the honest differences that may arise as to the value of a certain method of testing,—differences due to the fact that one engineer has to deal more or less exclusively with one class of metal, and thus is apt to jump at conclusions and apply his observations to all similar materials,—then we have, as a result, a hotch-potch of opinions and methods not at all warranted by facts, or creditable to our intelligence. Thus we have a different measure of quality of steel in every State and city, and we often find different measures in the same building, if not in the same engineering office. As Mr. E. Schroedter, secretary of the Society of German Iron Masters, said at the last convention of the International Union for the Unification of Methods of Testing: "The specifications for iron and steel for all kinds of construction vary not only in the different industrial countries, but, on closer examination of the details of the individual specifications, an extraordinary difference is found."

"While a strength of 72,000 pounds per square inch is asked for in one case, another purchaser prescribes 112,000 pounds per square inch. For structural material which is used in hundreds of thousands of tons for bridges and buildings, one engineer asks for material of 57,000 pounds per square inch with an elongation of 20 per cent. in 8 inches, while another one asks for 71,000 pounds per square inch."

"Still greater differences are found in specifications for sheets and steel castings. Not only are there great differences for quality, but there are also no uniform methods of testing and inspection."

While writing this, there march before the writer's mind, in single file, nine different test-sections of boiler steel, to measure the quality of steel for boilers. There may be others of which he does not know. Now, has boiler steel changeable properties, so that nine different measures are required as a guarantee, or is each of these measures correct, giving a true insight into the ability of the metal to resist pressure, and the effect of contraction and expansion to which steel in boilers is subject?

For other classes two, three, or four different specifications have to be filled. In a certain steel works where tires are rolled one hundred and twenty-eight sets of rolls are available, in order that all fancies may be suited. Allowing a liberal margin for necessary variations and individual judgment, thirty sets should be ample.

Who will eventually pay for the cost of making and maintaining the extra ninety-eight sets of tire-rolls, and the bother of using and changing them? Transportation, of course, will be burdened eventually with that cost. If it be urged that the cost per pound, distributed over the total number of pounds produced, is small, then why practise economy in any department of manufacture or transportation? Once the fact is fairly understood that we may get erroneous results by one method and reliable results by another, we shall have made a long stride forward to the unification of methods of testing. The object of all our testing and inspection of iron and steel, with but few exceptions, is to ascertain the rate of flow of a given metal and the force or load necessary to make it flow. The former indicates the degree of its ductility, and the latter its strength. Does a piece of metal or test-piece, representing a larger quantity of the same metal, show the same rate of flow under all circumstances, in whatever shape or at whatever speed the piece of iron or steel may be tested? It does not. If the test-piece is not of the proper size and shape, the flow will vary as the size and shape of the test-piece, and, if it takes more pressure or load to make the metal flow in one test-piece than in another, that test-piece will be faulty, and the result of the test will be erroneous and misleading by the difference in the loads respectively necessary to make the metal flow in a properly-shaped and an improperly-shaped test-piece. In other words, the results of one test will be different from those of the other test, other things being equal, and the engineer or consumer may deceive himself by just that difference.

If that difference is less than it ought to be, he assumes his material to be weaker than it really is, and takes more metal than he needs; if that difference is more than it ought to be, then the engineer assumes that his metal has greater strength than it really has, and his structure will be weaker than it ought to be. The criterion, therefore, of the most reliable method of testing is the selection of a test-piece of such shape and size that the metal will begin to flow, and flow at the same rate, under a pressure approximately equal to that which would cause the same metal to flow in the structure itself.

In the above we have not taken into consideration the factor of speed and other minor influences which go to make up the value of a proper method of testing.

To illustrate the foregoing let us assume that the engineer has based his calculations upon a limit of elasticity of, say, 30,000 pounds per square inch, and a breaking strength of 55,000 pounds per square inch. Now, if the method of testing, including shape of test-piece, speed of testing, and all other factors that may influence the result, show the metal to have a limit of elasticity of 38,000 pounds per square inch and a strength of 58,000 pounds per square inch,—and such differences can easily be produced,—then it is evident that the engineer is tempted to reduce the dimensions of his structure to save metal, and thereby make it too weak.

Now, since we have seen that there should be a uniform and standard shape and size of test-piece and methods of testing, how can we determine the proper dimension of test-pieces, leaving out of consideration minor details. If we take a beam, an eyebar, a rail, a girder, an axle, or a tire, and test it to destruction, noting carefully the behavior of the metal at the various stages of the performance, we learn when and how the structure begins to give way.

It has even been proposed to carry this into practice and test every axle, tire, eyebar, etc., before using it. However, since this would be expensive and not always practical, we make use of the information gained by testing whole structures to destruction.

If we now take two test-pieees of the material we intend to use for axles, beams, etc., and shape them like Nos. 1 and 2, test them, and compare the figures with the results obtained on the whole structure, we find a very marked difference between No. 1 and No. 2, and a still greater difference between No. 1 and the whole piece.

The difference between No. 2 and the whole structure is found to be comparatively small.

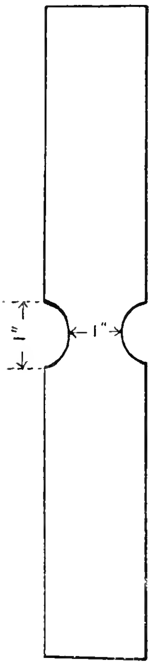


FIG. 1.

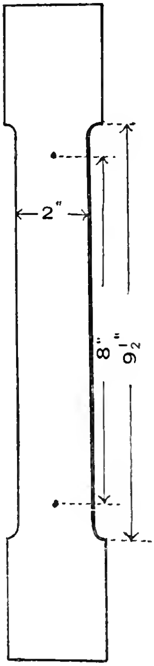


FIG. 2.

It is thus evident that the size and form of No. 2 more nearly represent the behavior of the metal when subjected to the same stresses in the whole structure than do those of No. 1. By a series of tests with various shapes and sizes we find that, as we depart from size and shape No. 2, we alter the results, and, the further we depart, the nearer we get to the results obtained with No. 1.

This clearly shows that the size and shape of a test-piece alters, modifies, retards, or accelerates the flow of the metal; hence that size is obviously the proper one which comes nearest to the behavior of the metal in the whole piece, and it should be the recognized standard.

It is needless to say that, within practical limits of economy and expeditiousness, the amount of metal in the test-section should be as large as possible, because it is impossible to make the metal so uniform that a small piece will represent the possible variations found in a plate or billet. A proper test-piece, then, is one that includes the greatest practicable number of particles of iron or steel in the same position, the same arrangement, the same physical and chemical state, as those in which they exist in the whole beam, axle, gun, or other structure. For various reasons it is manifestly impossible to have a single size and shape in all industrial countries and for all purposes.

Nor is this necessary, for, within certain limits, the results of tests with slightly different test-pieces are practically alike, and it is useless to try to squeeze the properties of metals for a given purpose within the strait jackets of cast-iron lines and formulas.

However, the above-mentioned principle should be a guide, and it seems to offer the best rational solution of the question, greatly reducing the element of chance. The recommendations of the International Union for the Unification of Methods of Testing Structural Material, which are not binding on its members, but only advisory, similar recommendations of a French commission, and those of the American Society of Mechanical Engineers, all tend in that direction, and would, if universally adopted, be a great step forward.

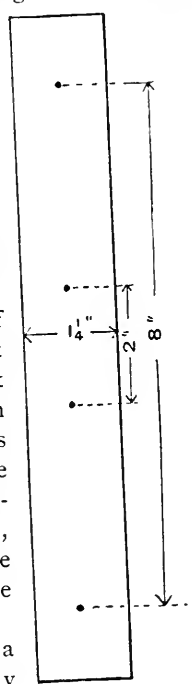


FIG. 4.

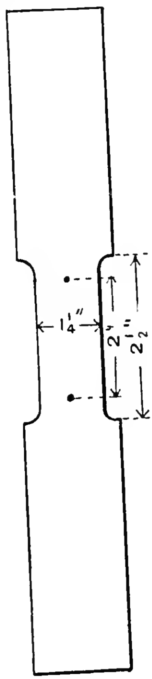


FIG. 3.

In the following tables of results of tests we can clearly perceive the influence of the form of the test-piece, while Barba's results of tests with geometrically similar and geometrically dissimilar test-pieces have ever been, and are still, authoritative in emphasizing the results of every-day experience. The reason for the higher strength and elongation in short test-sections seems to be that the fillets of the test-piece retard the flow, so that the particles, instead of sliding past each other naturally, are forcibly torn apart, to effect which a greater load is necessary. On the other hand, all the stretch takes place at or near the fracture, and, the section being short, there is a maximum of stretch to the inch, which is the unit of measure ment.

In a long section, as well as in a whole structure, the parts furthest away from the fracture do not stretch so much, and this reduces the percentage of stretch per inch. We can see this in Figs. 3 and 4. The tensile strength of No. 3 was 60,000 pounds per square inch with 46 per cent. of elongation in 2 inches, while the tensile strength of No. 4, which was cut out alongside No. 3, was 58,930 pounds per square inch with 54 per cent. of elongation in 2 inches, while the elongation was only 26 per cent. when measured in 8 inches, as shown. In No. 3 the flow of the particles was retarded by shoulders and fillet, and the particles were torn apart before they could slide apart. But, the section being short, the stretch at the point of fracture covered nearly the measurable length of section. In No. 4 there was no such hindrance, except what was caused by the grips, and the particles had a chance to follow their natural trend. Hence we find the strength somewhat lower; the elongation in 2 inches high again, but lower when measured in 8 inches.

Tables I and II show the results of tests made as the material came from the rolls, without preparation of any kind. They illustrate the difference between measuring the elongation in 2 and in 8 inches on the same bar.

TABLE I.—STAYBOLT IRON.

	Tensile Strength in 8 inches.	Elongation in 8 inches.	Elongation measured in 2 inches on an 8-inch section.	Excess in 2-in. section.
	Pounds per sq.in.	Per cent.	Per cent.	Per cent.
	48,800	29	45	16
	49,790	30	46	16
	49,300	30	43	13
Average.	49,270	29.7	44.7	15

TABLE II.—MERCHANT BAR STEEL.

	59,300	28	50	22
	59,000	29	46	17
	58,800	27	45	18
Average.	59,033	28	47	19

Table III shows the differences in results given by properly-proportioned test-pieces of boiler steel of 2-inch and 8-inch section. Table IV shows similar results obtained with much harder axle-steel. In both these tables it will be seen how much higher in strength and elongation the 2-inch section makes the metal appear. If the engineer takes this section as his measure of quality, he will assume that he has a strong and ductile metal, which is an absurdity, since ductility does not increase with increase of strength and rigidity. Since the 8-inch section represents more metal, it is fair to assume that the results obtained with that section are more truly representative of the quality of the metal than those obtained with the 2-inch section.

In Table V we see what extreme differences there are in results obtained with a 1-inch and an 8-inch section, as in Fig. 1 and Fig. 2.

Table V, as well as Table VI, explains how the strength of a structure may sometimes entirely depend on the knowledge an engineer or consumer may have of the value of one or the other method of testing as a measure of quality of structural material; and how desirable it is to have uniform methods of testing.

TABLE III.—BOILER STEEL.

	Tensile strength in 8-inch section.	Tensile strength in 2-inch section.	Elongation in 8-inch section.	Elongation in 2-inch section.
	P'nds per sq. in.	P'nds per sq. in.	Per cent.	Per cent.
	57,200	58,800	26	36
	55,600	57,300	31	38
	59,800	61,400	23	32
	62,100	64,700	26	32
Average.	58,675	60,450	26.5	34.5

TABLE IV.—AXLE STEEL.

	Tensile strength in 8 in. section.	Tensile stiength in 2-in. section.	Elongation measured in 8 inches.	Elongation measured in 2 inches.	Elongation measured in 2 in. on an 8-in. section.
	P'nds p. sq. in.	P'nds sp. q. in.	Per cent.	Per cent.	Per cent.
	88,900	92,400	22	25	36
	87,500	92,200	22	26	37
	86,500	91,800	22	27	36
	86,400	91,500	18.5	27	35
Average.	87,325	91,975	21.1	26.2	36

TABLE V.—RESULTS OF TESTS WITH GEOMETRICALLY DISSIMILAR TEST-PIECES.

Length of section, in inches.	Dimensions of Test-Pieces.		Tensile strength, pounds per square inch.	Elongation, per cent
	Thickness, inches.	Width, inches.		
1	½	1½	71,900	27
2	½	1½	65,100	26.5
4	½	1½	62,600	21
6	½	1½	60,300	19
8	½	1½	59,000	18.5

TABLE VI.—DIFFERENCES OF ELONGATION WITH GEOMETRICALLY DISSIMILAR TEST-PIECES.

Length of section, in inches.	Thickness of Plate $\frac{5}{16}$ inches.			Thickness of Plate ½ inch.		
	Width of Section.			Width of Section.		
	2½ in.	1½ in.	½ in.	2½ in.	1½ in.	½ in.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1	66	55	45	67	61	55
2	49	35	33	50	43	40
4	36	25	24	36	31	30
6	29	21	19	30	26	26
8	27	18	15	27	24	23

Table VII gives part of the results of Barba's researches as to the value, as quality measures, of geometrically similar and dissimilar test-sections. These results have been universally recognized as proof that the dimensions of a test-piece must be proportional to each other,—that length and breadth, or diameter, must harmonize. Thus, if we depart from the proper proportion in length and breadth, or length and diameter, we get higher or lower results, according as the test-piece is too long or too short.

TABLE VII.—BARBA'S RESULTS OF TESTS WITH GEOMETRICALLY SIMILAR TEST-PIECES.

Diameter of test pieces, in inches.	Length of section, in inches.	Elastic limit, pounds per square inch.	Tensile strength, pounds per square inch.	Elongation in 2 inches.
		EXTRA SOFT	STEEL.	
3/16	2	35,300	53,600	30.5
3/8	4	35,200	52,400	30.5
3/4	8	35,300	53,500	81
		MODERATELY HARD	STEEL.	
1/4	2	34,200	59,700	33
3/8	3	34,200	59,700	33
1/2	4	34,400	59,900	33
5/8	5	34,000	59,300	34.5
7/8	6	33,900	59,200	33
1	7	34,200	58,200	33
1 1/8	8	34,300	56,900	33
		HARD STEEL.		
1/4	2	50,500	92,200	20
3/8	3	52,000	92,300	19
1/2	4	50,800	90,800	18
5/8	5	54,000	90,000	18
7/8	6	57,800	90,300	18
1	7	54,200	90,200	18
1 1/8	8	54,200	91,000	19

All that has been said thus far goes to show that, other things being equal, the largest and geometrically proportionate test-piece is, theoretically as well as practically, the one that comes nearest to representing the quality of the material in the whole structure, and should be the accepted and recognized standard for structural iron and steel. So far, the discussion has followed the general principles involved and a formal presentation of proof in the shape of tabulated results. In the concluding portion of the article, to appear in the next number of THE ENGINEERING MAGAZINE, the points enunciated will be graphically illustrated.

SOME IMPORTANT MINING-TUNNELS IN COLORADO.

By Thomas Tonge.

THE increasing demand for, and appreciation in value of, gold; the depreciation of the gold price of silver, resulting in a narrower margin of profit on the richer ores carrying gold and silver, or silver only; the closing-down of many mines producing only medium- or low-grade silver ore; and the natural progress and improvement in the mining industry,—all aiming at greater economy of production and operation on strict business principles,—have rendered new methods absolutely necessary. This is seen in the improved drilling apparatus, the increased use of electricity for power, more economic methods of conveying the ore from the mine to the mill or the railroad (in the shape of aerial wire tramways and tunnels), reduced railroad freight charges, new ore-treatment processes, and reduced ore-treatment charges.

Many persons residing at a distance from mining districts have the most erroneous ideas as to the supposed simplicity and enormous profits of mining, apparently deriving their information from the data of phenomenal assays, or occasional pockets of rich ore, mistakenly assuming that such cases are average samples, and that ore can be dug almost as potatoes are dug. On the contrary, with the exception of a very few mines which may pay expenses from the grass roots down, successful mining to-day involves the maximum of practical experience, professional knowledge, and financial means. This is fully borne out by the following brief notice of some of the leading mining-tunnels of Colorado.

The outcrops of mineral-bearing veins or ledges are usually found on the steep, rocky slopes of high mountains, separated by deep and great gulches or ravines. As the veins usually dip into the solid interior of the mountains, shafts are sunk either on the veins themselves, ore being taken out as the process goes on, or in such proximity to the veins that they can be reached from the shafts by drifts or levels (which are really side tunnels from the shafts) and the ore stoped out and conveyed in small ore-wagons along such drifts or levels to the shaft, hoisted to the surface, and thence lowered down the steep mountain side to the nearest wagon-road leading to the mill or railroad. As the shafts are frequently hundreds of feet deep, and the mouths of the shafts frequently hundreds, if not thousands, of feet above the bottom

OUTCROP OF VEINS ON THE STEEP AND ROCKY SLOPES OF HIGH MOUNTAINS.

of the adjoining gulch or valley, the ore has to be hoisted by steam power to the surface (such steam power involving the conveyance of fuel from the valley to the shaft-house), and from the mouth of the

A COLORADO MINE. 1500 FEET ABOVE THE VALLEY.

shaft conveyed down the steep mountain-side. Sometimes the mountain-sides are too steep for a wagon, in which cases pack-animals—mules or donkeys—are used for the conveyance of supplies to the mine and of ore therefrom.

Again: it is frequently the case that, as the shaft increases in depth, water is encountered, which can be taken out (so as to permit the miners to work) only by pumping, thus involving expensive

A MOUNTAIN ROAD, COLORADO.

pumping-plants, in addition to the cost of hoisting the ore and subsequently getting it down the steep hill-side.

The expense of pumping, hoisting, and hauling seriously reduces the margin of profit, and in some cases extinguishes it altogether.

It is obvious that, under the above circumstances, through a tunnel driven into the mountain and reaching the ore bodies at a low level,—say, from the level of the bottom of the adjoining gulch,—

TRAIL FOR PACK ANIMALS, SAN JUAN MOUNTAINS, COLORADO.

not only can the ore be extracted from below and taken out almost by natural gravity or the minimum of power, thereby saving the expense of hoisting and subsequent conveying down the steep hillside, but also drainage can be had by natural gravity, thereby dispensing with the expensive pumping-plants, costly fuel, wages of engineers, etc.

Of course, not in every case is a tunnel feasible, and, in cases where it is feasible and where the circumstances will justify it, the interested parties may not have the necessary capital.

The last ten years have seen an increasing number of tunnel enterprises in Colorado, which may be divided into two classes: (1) those driven by mine-owners to develop their own properties; (2) those driven under the properties of other people, looking for revenue from the owners of such properties in the shape of royalties for the hauling of ore and the drainage afforded, and also looking to the probabilities of discovering, and thereby acquiring the ownership of, mineral-bearing veins which do not outcrop on the surface, and which have not been discovered under ground by the owners of the surface-workings. The question of *meum* and *tuum*, as between the owners of the tunnel and the owners of the surface mines, has probably not yet been finally settled. The important decision in the United States court at St. Louis as to the rights of tunnel sites—see Rico-Aspen Co. *vs.* Enterprise Co., 53d Federal Reporter, page 321—may have a very serious effect even on patented mines.

One of the first tunnels of any size in Colorado was the Bobtail tunnel at Blackhawk, Gilpin county, which was driven by manual labor in the "sixties," for the purpose of opening up the once famous Bobtail mine. Its original length was 1,200 feet, but 2,500 feet of extension has been added, tapping adjoining properties. As its greatest depth is only 450 feet, and as several shafts in the immediate vicinity were sunk years ago to a much greater depth below the surface than the tunnel, its present utilization for ore shipments and drainage is necessarily limited. Contemporaneous with the Bobtail tunnel was the Burleigh tunnel at Georgetown, Clear Creek county, which was the first tunnel in the State to be driven by machine-drills.

The Revenue tunnel (altitude 10,300 feet) is located at the foot of Hendrick's mountain in Ouray county, about seven miles from the town of Ouray (altitude 7,721 feet), the nearest railroad point. The primary object of the tunnel was to reach and develop the vein of the Virginius mine and various intermediate veins, carrying both gold and silver,—principally the latter. The Virginius mine has underground workings consisting of shafts sunk from the surface and levels extending from the shafts, aggregating nearly four miles in length, the output of gold and silver to date being about $3,000,000. The tunnel was commenced in the fall of 1887, and completed in 1891, work being almost continuous during that period, either on the tunnel itself or in "raises" or upward passages run from the tunnel to connect with the lower workings of the Virginius. The tunnel is 8 feet

CONCENTRATING MILL AT ENTRANCE OF REVENUE TUNNEL, ALTITUDE 10,300 FEET.

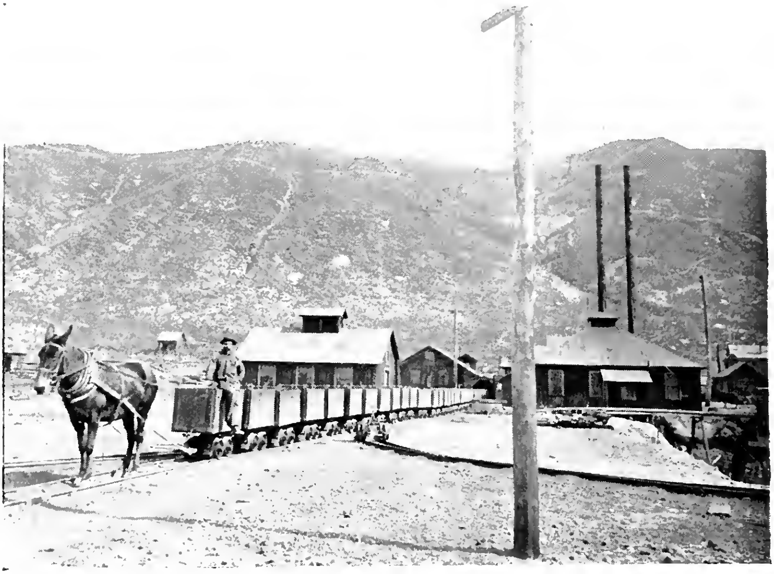
square; its total length to the intersection with the Virginius vein is 7,800 feet, or more than a mile and a third, from which intersection there is an extension on the vein for another half mile. From this extension the ore in the vein will be taken out from below, finally working up in such stoping to a vertical height of over 2,000 feet, for a length along the vein of 7,500 feet, the average width of the vein being about 5 feet. The greatest depth of the tunnel is 3,000 feet. It is equipped with a double track of 24-inch gage, operated by an electric motor. The total cost of the tunnel and of the water-power plant and other appliances immediately connected therewith (exclusive of mills) was $400,000, of which more than three-fourths was Colorado capital and the rest New York and Chicago capital. It is used both for ore shipments and drainage, and, without this tunnel and the reduced operating expenses effected thereby, the Virginius mine and adjoining properties would have had to close down in 1893 in consequence of the fall in the price of silver. The average value of the ore, as it goes into the mill, is about $20 per ton in silver and gold, and the following is the method pursued. The ore is brought out of the mine in small cars along the tracks in the tunnel and more than seven hundred feet of an outside extension thereof, to the top of a very large and completely-equipped concentrating mill of 300 tons' daily capacity (which cost upwards of $150,000), where it is concentrated, about five tons of ore being reduced to one ton of concentrates, the latter being then hauled to the railroad seven miles distant and shipped to the smelter two hundred and fifty miles distant. The concentrating mill is operated by electricity generated by water-power. Two water-power and electric plants which have cost upwards of $100,000 are in operation, and a third is approaching completion. Considering the large amount of capital invested in the mines, tunnel, mill, water-power, electrical plant, etc., the low grade of the ore, and the comparatively narrow margin of profit, this property is a striking illustration of the practical experience, professional skill, and competent management absolutely necessary in successful mining.

7800 FEET FROM THE TUNNEL ENTRANCE. MINERS GOING TO DINNER.

POWER-HOUSE, TIMBER-HOUSE AND BLACKSMITH SHOP, COWENHOVEN TUNNEL.

The zig-zag road up the mountain is the one up which supplies were hauled, and down which ore was packed, before the completion of the tunnel.

The Cowenhoven tunnel at Aspen is the most important enterprise of the kind in Colorado, and possibly the most successful in the United States. It was projected for the purpose of draining and furnishing transportation for the mines on Smuggler mountain, in all the deep mines on which the expenses of pumping have been steadily on the increase. In 1889 it became apparent that, unless some cheaper means of unwatering the mines and delivering the ore to the railroad tracks could be devised, the depth to which profitable mining could be carried on would soon be reached. When the tunnel was begun, the rates for drainage offered to the different mining companies were approximately equal to what they were then paying for pump-men's wages alone, and the rate for haulage, in round numbers, was one-half of the cost to the mining companies for conveying the ore by pack-animals or wagons from the mouths of the mines down to the railroad tracks at the foot of the mountain. Commencing near the tracks of the Denver & Rio Grande Railroad and the Colorado Midland Railroad, the tunnel runs under Smuggler mountain, and drains about thirty different mines, owned by six large consolidations. All ore produced on such properties, whether above or below the level of the tunnel, now comes through the tunnel, in most cases the ore cars



MULE TRAIN COMING OUT OF COWENHOVEN TUNNEL.

being loaded at the stopes and, without break of bulk, unloaded at the ore bins at the railroad tracks; in fact, all hoisting of ore and pumping of water to the surface of the mountain are now dispensed with, and the operating expenses greatly reduced. But for this, the majority, if not all, of these properties would have closed down in 1893 after the closing of the Indian mints, the repeal of the silver-purchasing clauses of the Sherman act, and the subsequent fall in the price of silver. The importance of this tunnel is shown by the fact that more than five hundred men pass through it to their work daily, while the daily output of ore and waste varies from three hundred to five hundred tons. In size it is 6 feet 8 inches high by 7 feet 8 inches wide, the present total length being 1¾ miles and the greatest depth 1,168 feet. The total cost, so far, has been $250,000, the money being furnished by three Colorado men. Work on the tunnel has been suspended since 1893, owing to the low price of silver, but, with more favorable conditions, it will be resumed, and the tunnel extended 2¾ miles to Woody creek, thus making the total length 4½ miles. It has a double track laid with 30-pound steel rails and is stone-ballasted throughout, and the tracks, switches, etc., have been laid with a view of introducing electric locomotives so soon as the improved price of silver justifies it. It is lighted from one end to the other by electricity, and equipped with the electric block-signal system. As illustrating the difficulties experienced in driving such a tunnel may be cited the fact that in this case large underground caves filled with dolomite sand and water (a most treacherous combination in the nature of "quicksand") were often encountered, the contents of which flowed out, sweeping the workmen like chips before the thick flood. Notwithstanding such obstacles, the progress of the tunnel averaged more than ten feet per day, sometimes for months together, and in one single calendar month a length of not less than 421 feet 6 inches was completed.

In the vicinity of Aspen there are also the Compromise tunnel and the Woody tunnel,—both important enterprises.

The Smuggler-Union property near Telluride, San Miguel county, is another instance of the economy of operation effected by a tunnel. In every possible instance natural gravity is utilized, for which the location of the property is specially adapted. It is reached by a spur of the Rio Grande Southern Railroad. One hundred feet above the railroad track is the concentration mill, and 1,700 feet above that is the mouth of the tunnel, at an altitude of 10,900 feet above the sea-level. From the mouth of the tunnel the surface of the properties extends, claim after claim, to the number of seven, in endwise succession, for a distance of 1½ miles to the top of the mountain, the upper end of the upper claim being 13,300 feet high, or 2,400 feet higher than the mouth of the tunnel. The various claims are operated from the surface by levels, one after another, and the tunnel, 2,500

INTERIOR OF COWENHOVEN TUNNEL, OUTER 2000 FEET.

feet long, is connected with some of the upper levels by means of a shaft 700 feet deep. On the entire property there are about 25 miles of underground workings. The ore from the above-mentioned levels is lowered down the 700-foot shaft, passing thence through the 2,500-foot tunnel to its mouth, and is then carried by wire tramway down to the mill, if it be concentrating ore, or to the cars, if it be smelting ore. A large part of the value of the ores in these mines consists of gold. From the various claims now constituting the consolidated property, in former years and under previous ownerships, about $7,-

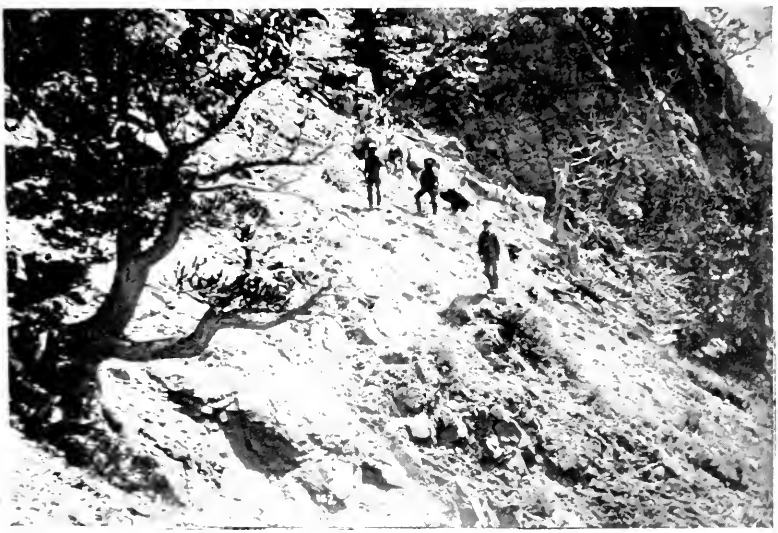
THE BREAST OF A TUNNEL, 1500 FT. BELOW THE SURFACE.

000,000 (according to smelter returns) was taken, and each of the mines accumulated a considerable dump; these dumps, eight or ten in number, aggregate, it is estimated, 150,000 tons, much of it mineral-bearing ore of low grade, which, under former conditions, could not be handled to pay expenses. By means of the shaft, tunnel and wire tramway, improved methods of concentrating, and reduced railroad and smelting charges, these large dumps of low-grade ore are now being worked at a profit. Under former management all supplies were conveyed to the mines, and the ore carried down from the mines on donkeys' backs, at a total cost of $5 per ton. By means of the

A BURRO PACK-TRAIN, COLORADO.

shaft, tunnel, and wire tramway, the same service is now performed at a gross cost of less than 50 cents per ton. The ore reserves are immense, and everything indicates that, working 200 men, it will take more than fifteen years to exhaust the mineral riches above the present level of the 2,500-foot tunnel. The whole property belongs to a private company consisting of a few wealthy men, 50 per cent. of the stock being held in Colorado, about 35 per cent. elsewhere in the United States, and about 15 per cent. in Europe and China. It is not listed on any stock exchange.

The Lamartine mine on French mountain near Idaho Springs, Clear Creek county, belongs to two private individuals in New York, and is credited with a total production of $3,000,000, mostly silver, its total underground workings aggregating about five miles in length. It is situated about five miles from the railroad, at an elevation of over



A BURRO PACK-TRAIN LADEN WITH ORE.

9,000 feet, or about 2,000 feet higher than the railroad. With the fall in the price of silver in 1893 and the increased inflow of water in the lower levels, it became a question of ceasing operations altogether, or driving a tunnel so as to dispense with the cost of hoisting ore or pumping water. The owners, as a preliminary, secured the control of mines on French mountain for a length of nearly two miles, with a greatest width of 1,600 feet, thus becoming direct owners of nineteen full claims, to say nothing of other claims under bond and lease. In October, 1894, they began to drive a tunnel, 8 feet by 8 feet, the work being started at both ends. It was completed in March, 1896, the total length being 4,508 feet, and the total cost being more than $60,000. Not less than 64,000 pounds of dynamite were used for blasting, and more than 300,000 cubic feet of rock were taken out. The greatest depth is 900 feet. By means of the tunnel 200 tons of ore and waste are now daily taken out with the minimum of power, and the various properties are drained, by natural gravity, to the extent of 400 gallons per minute, the estimated saving in operating expenses being from 50 to 60 per cent.


THE ROAD TO A TUNNEL.

As a further illustration of the mineral wealth of the general district in which the Lamartine mine is located, it may be stated that since 1859 a little strip of country, 4 miles long by 2½ miles wide, around Central City, Gilpin county, has produced over $80,000,000 of mineral, mostly gold, while the adjoining section of Clear Creek county around Idaho Springs has been a proportionate producer. Around Central City there are ten mines which have passed the million-dollar mark in their production. There are five to ten shafts reaching a depth of from 1,200 to 2,200 feet, and perhaps twenty mines ranging from 700 to 1,200 feet in depth, with many of lesser depth. In consequence of the excessive cost of pumping and hoisting, the working of some of these mines has been temporarily abandoned. In view of the fact that Idaho Springs on the main stream of Clear Creek, while less than four miles in an air line from Central City, is about 1,100 feet lower in altitude, it was simultaneously determined by various parties to run long tunnels, at a slight up grade, practically from the line of railroad below and above Idaho Springs, in the direction of the rich mines, and, by tapping them from below, not only to drain them automatically, but to take out the ore by natural gravity to the railroad tracks.

The first of these is the Newhouse tunnel, commenced in January,

AN UNDERGROUND JUNCTION IN A SIDE TUNNEL.

1894, representing British capital entirely. It enters the mountain from the railroad a short distance below Idaho Springs. Its total length will be 4½ miles, and several years will be required for its completion. The estimated cost is $2,000,000, the cost per foot so far being $35. The greatest depth of the tunnel is 3,000 feet, and at its proposed terminus near Central City its depth will be considerable. It is 12 feet wide by 12 feet high, is already in over one mile, and is being rapidly pushed by means of double shifts of men and air-drills operated by powerful compressors.

The second enterprise, the United States tunnel, is being constructed by capital from Belgium. It starts about half a mile above Idaho Springs, and is to run about 3½ miles, but as yet only a comparatively short length has been driven.

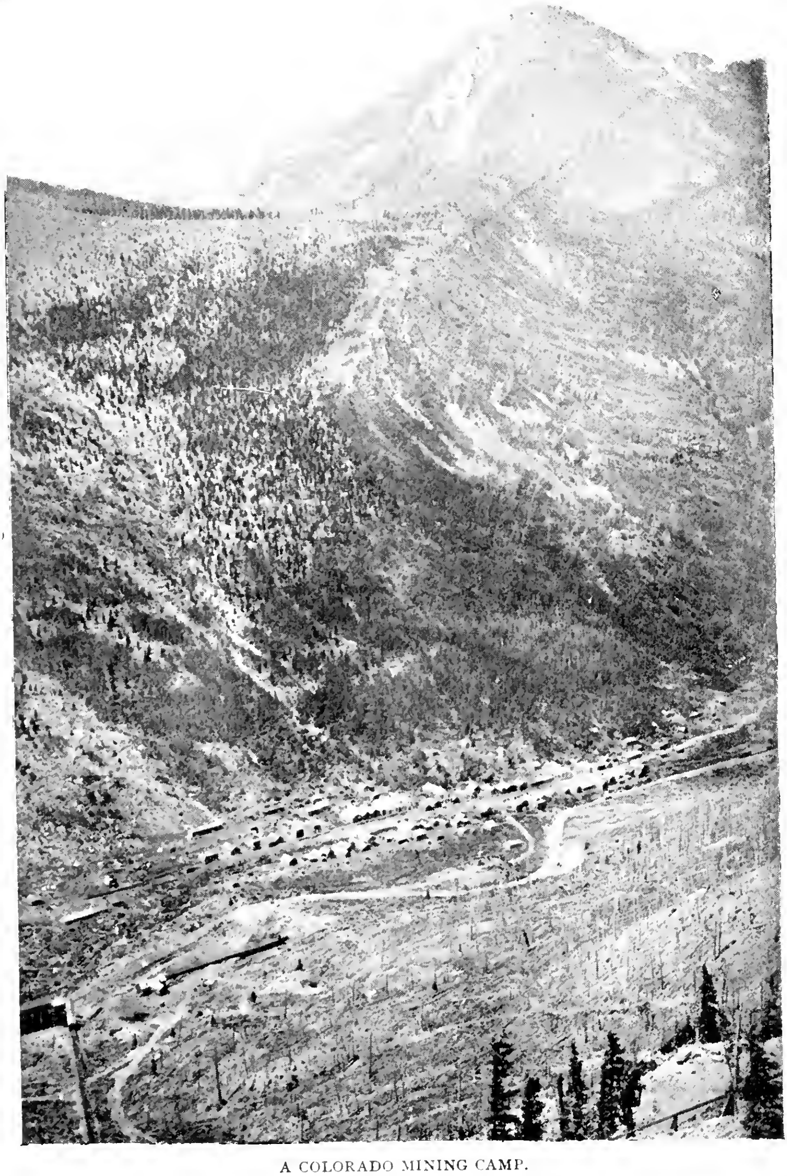
The third enterprise is the Pennsylvania tunnel, being driven by private Philadelphia capitalists, primarily to tap their own properties, consisting of one hundred and seventy mining claims, of which one hundred and thirty are patented, having an aggregate area of about 1¾ square miles. It starts about 3½ miles above Idaho Springs. It is already in 2,000 feet, and, when completed, will be 2½ miles long. At two miles from the mouth it will be 1,800 feet below the surface. It is about 8 feet by 8 feet in size, and is expected to cost about $250,000.

The fourth enterprise is the Knickerbocker tunnel, which begins three miles from Idaho Springs. It is 7 feet by 5 feet, and is already in 550 feet, and its total length will be 3,800 feet, the greatest depth being 1,200 feet. It represents Colorado, Missouri, and Illinois capital.

Briefly stated, these four tunnels will undermine, at a depth of from 1,000 to 3,000 feet, a mountain chain or group about four miles in diameter, traversed by an extraordinary number of parallel true-fissure gold- and silver-bearing veins, the richness of many of which has been satisfactorily proved by shafts from the upper surface, while the existence and richness of others are fairly assumed.

There are several important tunnels around Georgetown, Clear Creek county, known as the Burleigh, Ashby, Marshall, Diamond, and Victoria tunnels, each driven by mine-owners to develop their own properties, as was done at the Lamartine mine.

From an area a few miles square around Leadville, Lake county, from 1859 to the present time, gold, silver, and lead to the extent of $200,000,000 have been produced, and there are now several tunnel enterprises being pushed in that district, including the Yak tunnel and Agwalt tunnel. The Yak tunnel is already in 6,000 feet, but its total length will be 12,000 feet, or more than two miles, as it is to tap the



A COLORADO MINING CAMP.

Leadville gold belt; the estimated cost is $300,000, the money being furnished by a syndicate of Colorado capitalists.

There are also important tunnels around Rico, Dolores county, Creede, Mineral county, and elsewhere in Colorado, detailed mention of which is not necessary.

The foregoing illustrates very clearly the fact that the days of "wild cat" mining are, or ought to be, over, and that the days of intelligent mining are here, calling for a combination of practical experience, competent and economical management, professional skill, and ample capital. Conducted on the business principles now possible (such as are recognized as necessary in any other business), and looking for profits solely to ore shipments and not to stock manipulations and the gold and silver in other people's pockets, there is no more legitimate or profitable industry than mining. On such a basis millions of dollars can be safely and profitably invested in well-considered mining enterprises in the Rocky Mountain region extending from the British line to the northern border of Mexico.

THE RELATIONS OF STREET-CLEANING TO GOOD PAVING.

By Geo. E. Waring, Jr.

THERE is a very clear and close relation between the character of the road surface and the work of keeping it clean. It is possible to maintain a good state of cleanliness with any surface. Even the old cobble pavement of earlier New York, swept with a besom of birch twigs worked almost vertically over it, was, in a few streets like Bond street of fifty years ago, kept in excellent condition. While the earth between the stones was plainly to be seen, it was free from foreign accumulations, and the stones themselves were as bright as the shingle on a beach. In Turin—one of the cleanest cities of the world—a large part of the pavement is of small cobble-stones, hardly larger than a goose egg. It is kept in beautiful condition with the long broom of *ramalia* twigs, moved over it with a horizontal sweep. For all that, any form of cobble pavement is the last thing that a street-cleaner would suggest as desirable.

The permissible pavements, from his point of view,—those which are suitable for the heavy traffic of a great city, and which are at the same time kept clean at reasonable cost,—are: asphalt, wood, stone-block, and brick. Concerning the latter I have no practical knowledge, but it must be easy to sweep. Concerning all of them it is to be understood that they must be good of their kind.

It seems to me that *good* asphalt is, all things considered, and on moderate grades, the best of all pavements; second-rate asphalt is, however, one of the least desirable. I saw, occasionally during twenty years, the asphalt about the Bank of England, which was capitally well laid, and which was never allowed to fall into the least disrepair. It always looked new, and it must have had its beginnings of failure repaired almost nightly. It carried the heaviest and most constant traffic from morning till night,—heavier than any that we know here. It was always clean, though the only care it received during the day was the work of the red-coated boys, who flew in and out among the horses like sprites, brushing and scooping up the droppings as they fell. At night it was drenched with water and squeegeed and swept, until all trace of the day's wear was obliterated. I doubt if either wood or stone would have stood the test so well, or would have required so little interruption to traffic for necessary repairs. The fine wood-paved streets of London are not so well kept, though they often look cleaner, because wood does not show stains as asphalt does.

We have little asphalt pavement in New York that is either as good, or as well kept, as that described above, but we have much that is very good, and I incline to think this material better than any other available for our use, always assuming that it be kept in perfect repair. It is easy to maintain such pavement in a very fair state of cleanliness, by the use of an iron scraper-scoop for streets of moderate traffic, and of the scraper and broom for those more frequented.

Unless the surface is very uniform, the sweeping machine is not thorough in its work, even on asphalt, because it fills depressions with dirt, instead of cleaning them out. I have yet to see conditions where machine-sweeping is either as economical or as effective as hand-sweeping. It does very well for rough night-work and as a preparation, but really clean sweeping needs daylight and the attention of a faithful hand, under watchful supervision.

Asphalt has one quality that makes a "fair state of cleanliness" insufficient. From some cause, which even experts are not clear in explaining, it becomes so slimy and slippery when it begins to get moist under a light rain or a heavy mist that it is unsafe for driving—especially for the hauling of heavy loads—and for the bicycle. With a drenching rain this condition soon passes, and thoroughly wet, clean asphalt is safe for any use. If slime is allowed to accumulate, so as to form a film of mud, an asphalt street is a terror to all who drive or wheel; only sanding will make it safe. More or less often—every night in the case of the heaviest traffic—the surface should be drenched, and every trace of organic matter, and of detritus, should be washed off; and the scraper-scoop and the broom should be kept going during the day, removing all extraneous matter as fast as it accumulates. With such care, under proper administration, and with nightly attention to imperfections, asphalt is the most economical and the most practical of all pavements, and the most easily kept clean.

It is a great advantage that it is so entirely non-absorbent. All its filth is on the surface, where it can be got at, and all the water of rains and of the sprinkling-cart can be made to tell for its full value. If the street is kept free of litter, its washings can be run into the sewer without inconvenience; and what has to be gathered up and removed by carts is only what the street receives from its use,—legitimate or otherwise. There is no admixture of earth from below, such as we have in the case of most of our stone-block pavement. As a matter of fact, a perceptible portion of Manhattan island now works up through the crevices of our stone pavements, and is daily sent out to Sandy Hook lightship, at a cost to the city.

Under icy conditions, asphalt must be sanded, or those who use it must take their chances. In this case, as in that of sliminess, the fact is emphasized that asphalt is as bad, when left to itself, as it is good when properly taken care of. Its use entails constant care, but the care is well rewarded. No other outlay brings so good a return.

With the exception of a single block,—to be referred to hereafter,—we have no wood pavement in this city, and I know of no really good wood pavement in this country. In London, in Paris, and in other towns abroad, this material is used with great success as a top finish for a thoroughly-graded and well-concreted foundation. The foundation is the real pavement. The wood is, so to speak, a mere carpeting above it, to deaden sound and to take the wear. When the work is well done,—as, for example, in a case that I examined recently in Birmingham,—the wood may be worn away nearly to its full depth without in any wise disturbing the concrete on which it is laid. I saw an old wood covering being taken up, parts of which were not more than three-quarters of an inch deep. The foundation was absolutely unaffected, and the work of relaying fresh blocks was rapid and inexpensive.

Such pavement is even more agreeable than asphalt to drive over, and the sound of the horses' tread is deadened,—a great advantage. The material wears more or less well, according to the character of the work and the amount of the traffic, but always, under good conditions, well enough to be economical. Such pavements, except when quite new, seem to be more slippery than clean asphalt, and, as they wear, they become uneven. They have the disadvantage of absorbing a good deal of water, and, as ordinarily laid, they are not uniform in surface, the edges of the blocks becoming worn away so as to produce a somewhat ridgy condition. I found it the custom in England to sand these pavements regularly. Even in dry weather, they are sometimes sprinkled with sand once a day, and in wet weather twice a day, or oftener. This adds to the cost and difficulty of keeping them clean, and it is impossible to keep them as clean as asphalt, though they may look cleaner. This is an opinion formed from observation only, not from experience.

The one block of wood pavement in New York referred to above is in Twentieth street, between Fifth avenue and Broadway, where the material used is a variety of Australian Eucalyptus, called "Karri." This pavement makes more noise under the horses' feet than those of softer wood, and it is, in other ways, very like asphalt. It is said to wear better, and to be somewhat freer from the slippery condition under slight sliming, but it is evident from its use that it will require a certain amount of sanding to make it entirely satisfactory. It is as easily cleaned as any material in use in New York city.

Of stone-block pavement we have a very large amount, and a great variety of form and quality,—most of it thoroughly bad. This pavement has the great objection—even in its best development, as in Vienna—of being very noisy. The best in New York is not nearly as good as the ordinary Viennese work, and it is more difficult to keep clean. The usual stone-block pavement of New York is as good as the best for a very short time after it is laid, but, with its imperfect foundation and constant tearing-up and relaying in order to get access to the various underground pipes, it soon becomes a "humplety-bumplety" affair, difficult, and sometimes dangerous, to drive over, very unpleasant and difficult for wheeling, and wretchedly bad for cleaning. Under heavy traffic any stone-block pavement may be made to look cleaner, as seen from the sidewalk, than asphalt, but nearer examination discloses the fact that much dirt which ought to be swept up and carried away is simply lodged and packed in the crevices between the stones.

A very good example of a generally good stone-block pavement is that on Fourth avenue, the Bowery, and Park row between Seventeenth street and the post-office. It is not very difficult, with thorough hand-sweeping and a frequent collection of droppings, to maintain here a very creditable appearance; and, when we succeed in making the sweepers drive their brooms lengthwise of the stones, so as to brush well down into the intervening crevices, its condition is, on the whole, and most of the time, very good. Under the traffic that is usual on these streets, it would be difficult to make asphalt, though really much cleaner, look as clean as this stone pavement does.

All of our pavements would be much better, if it were possible to avoid the frequent tearing-up to which they are subjected; but, with our system of water- and gas-pipes, sewers, and their various house connections, it seems hopeless to attempt this.

Whatever the character of the pavement, we have one condition that adds enormously to the labor and cost of even tolerable cleaning,—namely, the bungling construction of our street-railroad tracks. These seem to have been laid, save on the cable lines and a few others, with regard only to the convenience of the railroad companies, and nearly all our street-car lines make the maintenance of a good roadway impracticable, and the work of cleaning difficult and unduly costly. We are reforming in this regard, as in many others. The tracks of the Broadway cable road and its extensions, and those of the Third avenue cable road, are a great improvement on anything we had before, while the track now being laid on First avenue is decidedly better than these.

But the old tracks of most of the horse-car lines are a terror to all who use the streets for driving or for wheeling. The worst form is the "centre-bearing" rail, which is a square ridge of iron, with a deep, wheel-wrenching channel on each side. These depressions are ideal harbors of dirt. Many of the very good asphalt streets, in the East Side tenement quarter, have two of these double channels, bordered with rows of granite blocks. But for this condition, these streets could be kept as clean as a floor,—as Lexington avenue, with asphalt close up to the rail, is kept now. It would pay the city well, if only in the reduced cost of street-cleaning, to reconstruct these tracks at its own expense,—laying a properly designed rail directly in the asphalt.

It is notorious that the cost of street-cleaning in New York is inordinately high. The cost, for sweeping alone, in 1896 will run up to about $1,155,000. With perfect asphalt pavement and the best form of car-track rail, this could be reduced by fully half a million dollars, and much better work could be done for the smaller amount. This shows that the relation between paving and cleaning is so important that all paving work should be carried out with full consideration of the requirements of the best methods of cleaning.

ELECTRIC CENTRAL STATIONS VERSUS ISOLATED PLANTS.

By R. S. Hale.

THE article entitled "Are Electric Central Stations Doomed?" which appeared in a recent number of THE ENGINEERING MAGAZINE, opens up so interesting a field of study, and leads to results so unexpected both in the light of theory and of practical experience, that I have been interested to go a little deeper into the questions raised, in order to see if the author's assumptions and conclusions depended on facts, or were merely theoretical. My work for the last three years has been chiefly in the line of analyzing records and tests, in general engineering, but chiefly in electric station work, for the Boston Edison Co., in order to find out why theoretical and practical results should be so different. It is thought that a like practical analysis of the comparative costs of electric current in isolated plants and in central stations might, even if perhaps inconclusive, be of interest to the readers of the paper referred to and to others.

The writer starts by assuming that he has obtained permission to supply electric current to the owner of each building in a square block of fifty houses. As a matter of fact, the only practical case is a hotel or large building using current equal to fifty houses, since a station for fifty separate houses would begin by supplying three or four, and would have to run ruinously underloaded for several years. If, however, the fifty houses are owned by the same landlord, the latter can compel the tenants to take electric light and no other, and to pay whatever price he may set. This is also the case in a hotel or office-building, except that here the price goes to increase the rent, and does not appear as a separate charge for electric light.

The model block station would, it is assumed, be called on to supply 2,500 lamp hours per day. This the writer works out to equal 137 k. w. h., and to need the generation of 186½ k. w. h. There is apparently one arithmetical mistake here, and probably more than one, for a moment later he works out the cost as \$4.81 per day, which he states to be 2.31 cents per k. w. h., whereas $\$4.81 \div 186\frac{1}{2} = 2.58$ cents, and $\$4.81 \div 137 = 3.51$ cents.

The arithmetical deductions from the figures will not, therefore, be discussed at this moment. We may, however, look over the figures on which the deductions are based, and see on what facts they rest. He assumes that, by means of utilizing part of the exhaust steam for heating, the coal consumption can be brought down to five pounds of coal per horse power per hour. Five pounds of coal per horse power per hour without such an allowance is an absurdly low figure for a plant of the size under discussion. Such a plant would have single-expansion, non-condensing engines of small size. There are no exact records of the output and coal consumption of a plant of the size in practice, the only figures we have being for short runs; and such short tests, though probably correct enough in themselves, are notoriously inaccurate as a basis for figuring actual results.

Lbs. Coal.	
K.W. hour.	E. H. P. hour.
6.1	4.5
8.1	6.
9.2	6.9
10.5	7.8
10.9	9.1
14.5	10.8
15.6	11.6
16.1	12.
20.4	15.2
17.9	13.3
17.9	13.3
17.5	13.
18.5	13.8
18.8	14.
20.4	15.2
18.8	14.
19.6	14.6
21.3	15.9
27.	20.1
23.8	17.7
23.8	17.7
23.8	17.7
13.7	10.2
12.5	9.3
11.7	9.5
10.6	8.9
9.	6.7
	328.8
average	12.2

We may, however, take the actual results in a large number of central stations as recorded in the report of the committee on data of the National Electric Light Association (*Electrical Engineer*, May 20, 1896), where we find the following reports on engines of the type used in isolated plants, although in stations of rather larger size. Even then the majority of these reports are based on only a portion of the years run, and so probably make a showing better than the actual results; whence it follows that the small block station, with two, or, at most, three, engines, would, in actual practice, give rather worse results. Still, taking the actual figures with no such allowance, we have 12.2 pounds of coal per horse power as an average, some of which can, in an isolated plant, be charged to heating. During April, May, June, July, August, and September we need no heat. During the other months we save nearly all the steam used, except during the time of heavy load; but the heavy load, unfortunately, comes from 4 to 6 P. M.,—that is, just the time when the offices are closing up and the demand for steam heat is least. Still, during the winter months the average use of the light is the greatest, and it will be fair to assume that enough is saved during the six winter months to bring the average coal per horse power for electricity down to one-half the total coal. That would make 6.1 pounds of coal as the average per horse-power hour chargeable to electricity, without considering the extra cost due to the fact that an isolated plant is smaller and worse managed than a central station using similar engines.

The figure assumed in the article under discussion was 5 pounds per horse-power hour, allowing for all savings. The cost of labor is taken at $2.50 per day. This is about as low in proportion to the actual cost as is the 5 pounds of coal per horse-power hour, taken above. A responsible engineer who can take charge of the plant, run the engines, take care of dynamos, and look after storage batteries, and yet is satisfied with $2.50 a day, is hard to find. If storage batteries are not used, then, in order to give the same quality of service as that supplied by the central station, two engineers must be on duty twelve hours a day each. In addition, though the labor of the fireman during the winter is, of course, chargeable against steam heat, yet during the summer his wages must be an extra expense.

The cost of water is referred to briefly. This is a very slight tax on the isolated plant in a few cities in which the charge is so much per boiler per year, since the number of boilers is the same, whether they be used for heating or lighting. If, however, the water be sold by meter, then the water for all the steam made must be charged against lighting, whether it be used for steam heat or not. The reason for this is that, if the boiler be used for heating only, the condensed steam can be trapped back to the boiler and used over. If the steam be first passed through an engine cylinder, the oil makes all the condensed steam in the heating system unfit to use in the boiler, and fresh water must be taken from the city mains and paid for.

There are, however, numerous expenses that are incurred by the central station as part of its cost for the production of current, besides those that the writer now under review has considered as the sum total of the isolated plant costs. Let us see if, as a matter of fact, coal, labor of engineer, oil and waste, and water, make up the sum total of the costs. Taking up, first, a charge made in all central stations under one name or another,—*viz.*, management or superintendence,—let us see if this is not as real a part of the cost of an isolated plant as it is of the cost of the central station.

Recently a gentleman who was considering the purchase of an isolated plant for a building in which he was interested said that his isolated plant would cost him nothing for superintendence, because he would hire a good engineer and depend on him.

"I do not believe," he added, "that I myself would spend more than an hour a week, in all, on my isolated plant." He was making, possibly, $6,000 a year, but did not stop to reflect that, at this rate, his hour a week amounted to $2 a week, or $100 a year.

The cost of clerks, accountants, office-expenses, etc., is an item very similar to management. In the isolated plant all this is charged, not against the electric light and power, but against the general expense of the business; still, it is really as much a part of the cost of electric light as is the management. A frequent assumption is that the bookkeeper or some other clerk attends to the electric-light matters. But then, suppose the general business improves a trifle, so that all the clerks are fully occupied on general business. Then the isolated plant makes another clerk necessary.

Take another example of an account not generally charged against isolated plants,—*viz.*, taxes. If the building stands in the name of a private individual, the isolated plant sometimes escapes taxation; but if in the name of a corporation, it must stand its share.

But, though enough has been said to show that the method pursued in the article is unreliable and inexact for the purpose in hand, yet it is not to be thought that it is proposed here to recommend any change in the account-keeping of those owners who are still running isolated plants. The object of keeping accounts is merely to keep track of expenditures in order to avoid waste of money and to keep the business within proper bounds.

Hence, unless any account in the ledger or any entry on an account saves in the end more than it costs to keep it, it is better not to keep it as a separate item. Now, this is just the case with a-half or two-thirds of the true expense of an isolated plant. To be theoretically exact, the isolated plant should be charged with its share of the taxes, insurance, general expense, office-expense, janitor's pay, etc., but, practically, it would cost more to divide these up among different accounts than could possibly be saved from year to year; so that the wisest way for the manager of an isolated plant is to charge against the isolated plant only the obvious expenses, and to compare these from year to year with the costs for the previous year. His accounts will not show the true costs, but the loss by the error will be less than the cost of making the subdivisions. When, however, the central station is in a position to supply current, the case is entirely changed, since there is now a chance to save all the indirect expense and bother of the isolated plant as well as the direct expense that appears on the accounts, and these indirect expenses must be added to get the true measure of the amount that can be paid for central-station current.

It is an unfortunate fact that the owner of a building must make up his mind for himself which of the two costs is the lesser, since, practically, every one competent to judge is interested on one side or the other. On the one hand, it is to the advantage of the central-station to sell the current at once rather than to hunt for other customers, and, on the other hand, the boiler-maker, the engine-maker, etc., even to the consulting engineer, get larger profits out of fifty small isolated plants than they would out of one central station.

All that this paper can do, therefore, is to show a way of determining the question which, though it would be a very impractical way so far as account-keeping from year to year is concerned, is yet the only practical method of computing the costs when the question arises whether a new isolated plant shall be put in or an old one renewed. The method is as follows:

Determine what it would actually cost with the isolated plant for each item, including all expenses.

Determine what it would cost with the central station for each item, including all expenses (profits or dividends to be considered as an expense).

Then that which is, on the whole, the cheaper, paying due regard to quality, is the better.

First, let us determine the proportionate size of the two plants, assuming a certain amount of current. The isolated plant needs one, or, at most, two engines to supply its load, and must have, at least, one engine as reserve, making a 50 per cent. or 100 per cent. reserve. The central station has from twenty to fifty engines, and can get along with from four to ten as reserve, or 20 per cent. The central station has, however, to waste about 10 per cent. of its power in transmitting the current, making additional machinery necessary. Finally, the central station is able to double up at times on the use of its machinery, since all the light and power in different parts of a city will not be in use at the same time, while the isolated plant must be prepared to run a much larger proportion of the light and power connected to it. Taking all these considerations together, the central station needs, in proportion to the current used, only about two-thirds of that amount of machinery which the isolated plant needs.

The boilers for the isolated plant cost nothing beyond the expense of making them fit for high-pressure steam, as they must in any case be provided for steam heat.

Neither are the underground or overhead wires needed at all for the isolated plant (unless, of course, it supplies several buildings).

The cost or rent of land is much greater for the isolated plant, since the land must be located where the building is, and not only takes up room that could be used for store-room or rented, but also, on account of the heat and danger from high-pressure steam, and of the tremor of the engine, lowers the rental value of the building. *

* The writer of the former article assumed that the cost of land, or, what comes to the same thing, the rent, would be negligible. I, therefore, took occasion to ask the manager of one of the large real-estate trusts in Boston what rent he would charge me for space enough for isolated plants in some of the buildings. He very kindly went over the matter with me, and we found that, in a building corresponding in location to the Boston Edison Station, the rent for enough space for a small isolated plant would come to about $100 a year, and this was the lowest rate in the list he gave me. In locations in the central portion of the city the rent was about $750 for the same amount of space. In addition to these charges, he said he should have to require the isolated plant to be built so as to not interfere with other tenants, and in some buildings he could not allow an isolated plant in any case.

The minor items of capital account, such as cash kept on hand for payment of operatives, bills receivable, fuel on hand, supplies on hand, etc., are all as large for an isolated plant in proportion to its size as for a central station. At first sight, perhaps, items like "accounts receivable" are not part of the capital account of an isolated plant. It takes, however, only a moment's reflection to see that, if the light is included in the rent, the holding back of a rent bill by a tenant inflicts exactly the same proportional expense on the isolated plant that the holding back of a light bill inflicts on a central station. The same principle applies to the rest of the capital charges.

Now, the costs of the electric lines and conductors, and of the boilers, make up in all about forty per cent. of the capital of the central station, nearly all of which is saved by the isolated plant. An isolated plant must provide the capital for the other items in proportion to its size, and this is fifty per cent. more in proportion to the current used, on account of the extra fifty per cent. of machinery needed by the isolated plant, as shown above. One hundred and fifty per cent. of 60 per cent. is 90 per cent., leaving the isolated plant apparently 10 per cent. cheaper in first cost than the central station. Against this, however, must be set the fact that the central station is a big undertaking, and the isolated plant a little one, and that buying in large quantities is cheaper than buying in small.

The first cost of the isolated plant is then more than 90 per cent. of that of the central station. The fixed charges are:

(1) *Depreciation.*—This will be greater on the isolated plant, since it will not have as skilled management as the central station.

(2) *Taxes.*—These will be less for the isolated plant, provided it is in a private name. If it stands in the name of a corporation, the taxes will be the same.

(3) *Insurance.*—This will be the same, on the plants themselves. The isolated plant, however, will involve a higher rate of insurance on the building containing it.

(4) *Interest.*—The true interest is, of course, the same in both, this being the interest that is paid merely for the use of the money. The interest that represents profit or dividends is also the same in both cases, since the owner wants to make as much profit out of the money he invests in an isolated plant as he would have made on the same money if he had invested it in some other way. The interest due to risk is greater for the isolated plant, for there is greater risk of loss when money is invested in an electric plant that is to be owned and managed by a non-expert than when it is invested in an established business, like central-station lighting.

Taking all in all, then, we find that, though the first cost of the isolated plant may be ten per cent. less, all included, than the cost of the central station and its street conductors, yet, since in the isolated plant nearly all the fixed charges are a larger percentage of the first cost, it is fair to conclude that the final expenses for the above items are as much for the isolated plant as for the central station.

It is to be noted that none of the above items are usually charged against the cost of electricity when the latter is supplied from an isolated plant. The owner of the isolated plant can make no saving from year to year by dividing up these items on his accounts, so that the bother of splitting up the insurance bill, the interest, etc., is not warranted, until there is a chance to reduce those items by taking street current, instead of putting in a new isolated plant.

General expense, office-expense, stationery, management, etc.—These items are greater for the isolated plant, except for the cost of selling, which will be spoken of below. No merchant would look out for and manage his neighbor's isolated plant without expecting a very reasonable compensation for the time and trouble to himself and his clerks. We may, if we choose, look at it in another way. If the owner has an isolated plant in one building and then buys the adjacent building, does he find it cheaper to put in another isolated plant, or to run the wires across? Yet, if the saving in running one isolated plant instead of two isolated plants is not due to the saving in cost of superintendence and management, where does it come in?

Selling.—It is obvious that the true cost of managing the isolated plants is greater than the cost of managing the central stations, even if no charge for management be made against the isolated plants on the books. The cost of selling electricity is not apparently a charge on the isolated plant. It is, however, really a charge in one sense, as follows. The central station always has before it the possibility that its customers may drop off, and so it must keep in with them, which costs money. The customers, therefore, always have the privilege of reducing the amount of current they use if the building should not be fully occupied, or of stopping altogether if business should be bad. This is worth something to the customer, while, on the other hand, the owner of the isolated plant binds himself to pay the interest, taxes, insurance, etc., on his plant, until it is worn out, whether the building is full or not. If the customer of the central station is willing to forego his privilege of change, and to make a contract for a term of years, he can frequently get a reduction in price corresponding to the cost of advertising and selling.

Repairs.—The cost is greater for the isolated plant, since the management is not so skilled. It should be noted, however, that the records of even a number of isolated plants will not show this, for the following reason. Part of the repairs are due to the wearing out of minor parts of the machinery, and part are due to smash-ups. Out of the fifty engines at the central station, perhaps one will break down every other year, and the cost will be charged to repairs. Out of the engines of fifty isolated plants, one will break down every year. This, however, will, in the majority of cases, lead either to giving up the isolated plant, or to putting in an improved engine or dynamo, the whole cost of which will be charged to construction, and not to repairs.

Lamps.—The cost of lamps will be less to the central station than to the isolated plant. Beside the fact that the central station can buy cheaper in large quantities, it can afford to test each lot of lamps. Of course, if, as in some cities, the central station does not supply lamps free, then the cost is no more (and no less) whether the current is made in the isolated plant or the central station.

Street Repairs.—The cost of repairs on the street conductors is zero for the isolated plant, but the cost of repairs to underground street conductors is less than 1 per cent. on the cost in actual practice, and generally averages less than ½ per cent.

Meter Department.—The cost of the meter department of the central station, for measuring the supply to the customer, is entirely saved by the isolated plant. The meter department, however, of most electric companies more than pays for itself by allowing the customers to save light when the customers care little about it.

Labor.—The cost of labor in the boiler room is greater for the central station, since the isolated plant can charge its boiler-room labor during the winter to heating. The engine-room labor and the labor on electrical apparatus is, however, greater for the isolated plant, and this portion of the labor is, from actual experience of the electric companies, two-thirds of the whole cost of labor of producing electric current. When it is remembered that the amount of labor required depends more on the size of the plant than on the number of hours it is run, and that the isolated plant must be fifty per cent. bigger than the central station to supply the same amount of light, it is seen that, in fact, all the boiler-room labor in an isolated plant might be charged to heating without bringing the isolated-plant cost of labor below the central-station cost for the same amount of light. Generally, if the boilers do not take up a fireman's whole time, he can spend the spare portion in doing odd repairs and cleaning in the basement, but sometimes in a heating plant the fireman claims that he would be willing to run an engine also at no increase, or a small increase, in his wages. As a matter of fact, however, after the isolated plant is put in, the fireman-engineer will come to the owners and explain that, though he can actually run the plant alone, it will be economy to give him an assistant engineer or fireman. Thus, in the end, the cost of labor will be found to be as above stated.

Coal.—The average amount of coal per horse power was found to be 12.2 in the central stations using the type of machinery that is used in the isolated plant. The isolated plants would, of course, be more expensive by reason of their smaller size and since the engines will be more usually underloaded. Against this must be set the fact that about one-half of the year's coal can be charged to heating, bringing the net pounds of coal per horse-power hour down to 6.1 pounds. The cost of coal per horse power is not quite as low, since the central station buys its coal in large quantities at a cheaper rate, and is generally situated either on a railroad track, or on the water front, while the isolated plant must buy in small quantities, and must pay forty to fifty cents per ton for carting. Then, too, the central station can often burn a cheaper grade of fuel than is practicable for the isolated plant. In spite of these advantages, the isolated plant has a considerable advantage, so long as the same type of engines is used in both plants. The isolated plant is limited, however, to one type of engines,—*viz.*, single-expansion non-condensing, none other having been found practicable in small plants. The central station can use triple-expansion condensing engines, which have, by actual tests, given a horse power for 1 ¼ pounds of coal per horse-power hour, or only one-tenth the average coal per horse power for plants that are even more economical than the average isolated plant. This is, of course, not a fair comparison, though as fair as the method practised by some engineers. The actual central-station records taken from the report from which the figures for the isolated-plant type of engine were taken show an average of 3.7 pounds of coal per horse-power hour for the triple-expansion condensing engines, and less than five pounds per horse-power hour for the compound condensing engines, against 12.2 pounds per horse-power hour for the isolated-plant type of engine. Hence we see, after allowing for the higher price paid per ton by the isolated plant, more than one half the coal might be charged to steam heat and still leave the coal bill greater than that of the central station in proportion to the current supplied.

Oil, Waste, and Miscellaneous Supplies.—These are, in general, proportional to the size of the plant, and are, therefore, in proportion to the current, much larger for the isolated plant than for the central stations.

Water.—The cost of water is the final item to be considered. If the water rate is so much per boiler per year, irrespective of the amount used, the advantage is much in favor of the isolated plant, but, if the charge is proportional to the amount consumed, the cost is, in general, proportional to the total coal bill, and *all* the water must be charged against the isolated plant, for the reason that the condensed steam cannot be safely put back into the boilers, on account of the oil in it. In addition, the central station, by reason of using large quantities, generally gets a lower rate, so that the cost for the isolated plant is more than double that for the central station.

Summarizing, then, we find that the isolated plant is very seldom charged with any part of its share of the taxes, insurance, depreciation, or interest, and that large portions of the management, accounting, repairs, labor, and miscellaneous expense of an isolated plant are also charged against other accounts.

We find, however, that the first cost of the isolated plant is actually less than that of the central station only in the items of boilers and electric street conductors, the isolated plant being more expensive in first cost for engines, dynamos, real estate, and every other item of capital account.

We find that the isolated plant costs less to operate than the central station only in the items of boiler-room wages and, possibly, water, advertising, metering the current, and taxes, the cost being greater for management, accounting, repairs, labor on the engines and electrical apparatus, coal, miscellaneous supplies, insurance, interest, and depreciation.

We find that a comparison of the real expenses of an isolated plant with those of a central station shows that not only is the total first cost practically as much as for the central station in proportion to the current supplied, but that, if all the expenses are included, the cost of operation of an isolated plant is far greater than that of a central station.

The only possible conclusion, then, is that it is cheaper for the real-estate man, the hotel-keeper, or the dry goods merchant, to devote his brains and intelligence to making money in his own field, where he is an expert, than to waste his time on a small electric plant. No matter how skilfully he may run his isolated plant, he will lose money, or—which comes to the same thing—not make as much money as he would have made had he employed his time, his capital, and his brains where they are most effective.

And, finally, we see that the central station is not doomed, but that, when the true comparative costs are accurately known by the owners of the buildings, an isolated plant for electric lighting will be as much of a curiosity as an isolated plant for gas lighting would be to-day.

PIONEER LOCOMOTIVES IN ENGLAND AND AMERICA.

By Alfred Mathews.

WHILE the actual beginning of steam railroad transportation in this country was in the early thirties, and the trial of the first practical locomotive that ever turned a wheel upon a track in America was made on August 9, 1829, in the woods of northeastern Pennsylvania, at Honesdale, under the auspices of the Delaware & Hudson Canal Company, there were numerous foreshadowing experiments, both in England and America, many years earlier.

Many minds were occupied with the alluring, but elusive, locomotive idea from the time when steam was first demonstrated a success in the operation of the stationary engine. In America the bee buzzed early and persistently in the bonnet of Oliver Evans. Cugnot, of France, brought out a steam carriage in 1771, and Evans is known to have been at work upon the same idea in 1772. The Frenchman patented his invention in 1784, and in 1786 the American, again two years later than his Gallic rival, applied to the Pennsylvania council for a patent upon his.

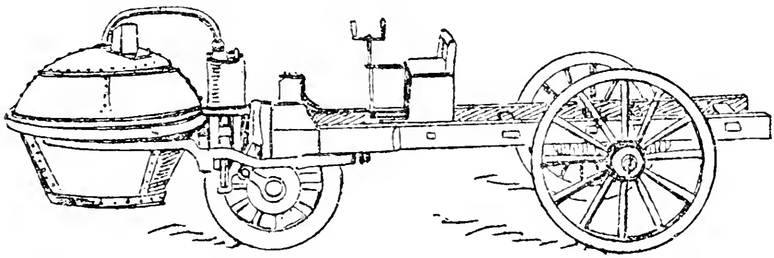
A few years later Evans's locomotive—for such it was, though not a *railroad* locomotive—was given a trial, and this was undoubtedly the first steam carriage, of any kind whatever, run in America. It was a strange, amphibious monster, designed to travel on land or water, and less a success on the former than on the latter.

Tramways—with tracks of stone, at first, and later of iron—originally came into use in British coal mines, and it was by them that the idea of the railroad was suggested, which, being united with that of the traveling steam engine, made the locomotive idea practicable.

It was in 1802 that Trevithick and Vivian, two Cornish engineers, brought out a steam carriage designed for common roads, or, by a modification of the lines of the wheels, for railways. After repeated improvements, it was placed on the Merthyr-Tydvil Railway in South Wales in 1805, and was a practical success in drawing coal cars.

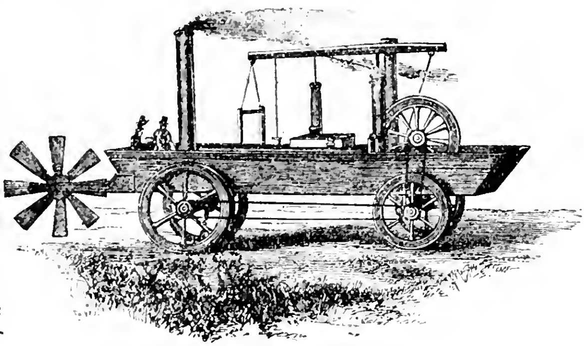
This was the first locomotive ever run on rails, and for this and several other reasons it was perhaps the most remarkable example in the history of locomotives. The body of the carriage was in close imitation of the old English stage-coach. It was high-pressure and non-condensing, and had several features that were then new but have been retained in the light of later experience. The main item of interest in regard to this steam-power Welsh wagon, however, was that it practically demonstrated the utility of the railway locomotive.

Various productions followed, but, with them all, not until twenty-five years after the time of the invention of the *track* locomotive (Trevithick and Vivian's) was the railway used for any other purpose than that of coal-transportation.



THE FIRST STEAM CARRIAGE. DEVISED BY CUGNOT, 1771.
From an old cut in *The Engineer*, London.

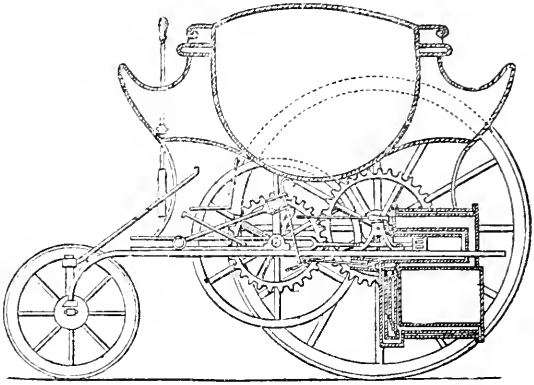
Blenkinsop's "Lord Wellington," made in 1811, for a colliery near Leeds, was notable as having as its means of propulsion a cog-wheel fitting into a rack on one side of the track, the idea being that the tractional adherence of the driving-wheels to the rail was not sufficient. Hedley's "Puffing Billy" of 1813 was another moderately successful locomotive, and it is curious to note that it was used, more or less, until 1862, when it was given an honorable retirement in the British patent-office museum.



EVANS'S LOCOMOTIVE, 1786.

One of the odd ideas of early locomotive building was the supposed necessity of vertical cylinders, which nearly all the mechanicians of the time regarded as of value in pressing the wheels down upon the track, an idea quite analogous to that of lifting one's self by one's boot-straps.

George Stephenson retained this idea in an engine which he built in company with Dodd, in 1815, and in several later ones; indeed, it was modified in the famous "Rocket" only so far as to tilt the cylinders at an angle of about forty-five degrees.

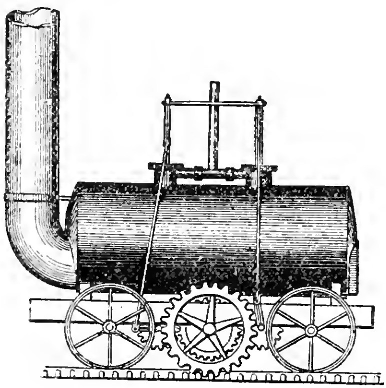


TREVITHICK AND VIVIAN'S LOCOMOTIVE, THE "MERTHYR-TYDVIL," 1805.

What has been regarded by some as the birth-day of the railway locomotive occurred on September 27, 1825, with Stephenson as the father of the event. The Stockton & Darlington railway had been built, and, through his persistent importunities, laid with iron, instead of wooden, rails. It had been intended merely for horse-draught, but the inventor prevailed upon the owners to allow him a trial of his steam locomotive.

Stephenson himself was the driver on that occasion, and, before a tremendous crowd of curious and, for the most part, incredulous people, he drew a train of nearly thirty wagons, loaded with passengers and coal, at a speed of twelve or fifteen miles per hour. Thus the first train that ever carried passengers made its journey in safety, and the enthusiasm of the multitude was indescribable.

But, notwithstanding this demonstration, the locomotive was still unmercifully ridiculed by the majority. Nor was this ridicule confined to the ignorant classes; the ablest engineers contended that it was ridiculous to suppose that steam could ever be practically employed in competition with horse power for transportation. Almost incredible as it may now seem, it is a fact that political economists inveighed against the railway and the engine as constituting an imaginary reform, which, even if successful,—which was very doubtful,—would deprive stage-drivers, teamsters, and inn-keepers of their livelihood! It was in the face of an almost universal opposition, of the wild, unreason-

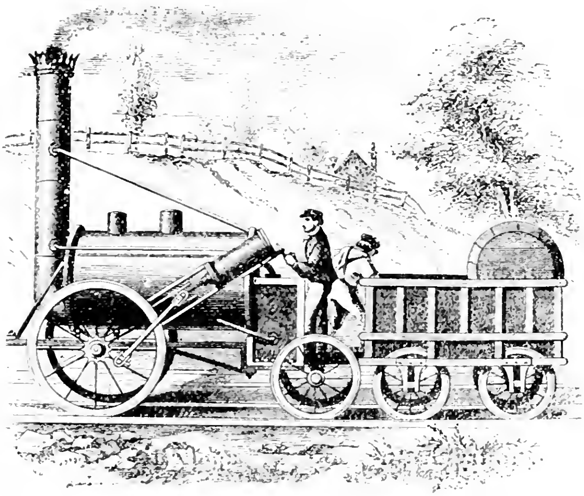


BLENKINSOP'S LOCOMOTIVE, "LORD WELLINGTON," 1811.

able kind, that a few men, led by the great Stephenson, labored steadily onward, and finally established the railroad and the locomotive as institutions of the land.

A great step in advance was made in 1829, when the Liverpool & Manchester Railway was finished. This was the most extensive and elaborate work of the kind that had ever been undertaken,—the first passenger railroad in the world,—and its opening on September 15 marked an era in civilization.

It was for this road that the famous "Rocket," already alluded to, was built by Stephenson. The directors had offered a reward of £500 for the best locomotive that should fulfil certain conditions, among them curiously enough, read in the light of the recent smoke-abatement agitation, being a provision that it should *consume its own smoke*. Besides this, it was to draw three times its weight at a rate of not less than ten miles an hour, the boiler pressure was not to exceed fifty pounds to the square inch, and the weight was not to exceed six tons. Of three engines which contested for supremacy the "Rocket" took the palm, attaining as its greatest velocity twenty-nine miles per hour and an average of fourteen miles, while drawing a tender and two loaded cars, the former weighing, with its water and coke, 3½ tons and the latter 9½ tons,—a total of nearly 12¾ tons. The consumption of coke was only 217 pounds per hour.



STEPHENSON'S "ROCKET," 1829.

The day was marred by one fatality, the locomotive claiming the first of the thousands of victims that were to lose life under its wheels. This was no less a personage than Mr. Huskisson, home secretary in the British cabinet, who, while talking with the duke of Wellington, in a throng of sight-seers, was run down by the now historic "Rocket." He was not killed outright, but died within a few hours, having in the meantime been conveyed to his house on another engine, the

"Northumbrian," by George Stephenson. On this ride the engineer pushed his machine to a speed of fifteen miles in twenty-five minutes, —a rate of thirty-six miles an hour, the highest that had then been attained.

The railroad and the locomotive were now unalterably fixed as a new force in the world's civilization. America closely followed Great Britain, and in its rapid adaptation and perfection of the machine outdid the older country. But it nevertheless was the case that the pioneer in America among practical locomotives placed on a track for traffic was an immigrant from England. It is one of the curiosities of railroad and locomotive history that it was not in, or near, any one of the great cities that this first locomotive was put upon the rails, but far away in the then raw region of northeastern Pennsylvania, in the woods and among a few scattered, newly-settled farmers.

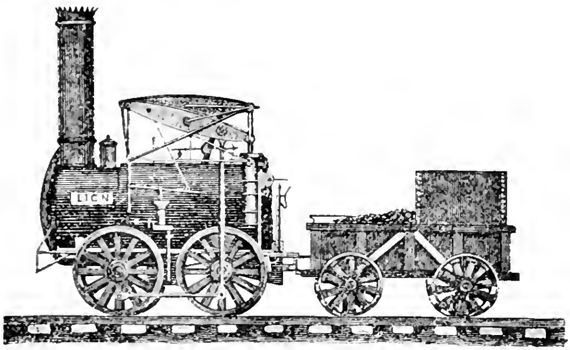
The manner in which it came about that the pioneer locomotive in America was to be set at work in so remote a spot was this. Two Philadelphia Quakers, John and Maurice Wurts, about ten years prior to 1829, penetrated that wilderness, and heroically began and pushed forward the great work which later was assumed and carried to completion by the Delaware & Hudson Canal Company,—that of getting coal from the Lackawanna valley into New York. From the Lackawanna (at Carbondale) the company had built a railroad over the Moosic mountains to the forks of the Dyberry (the site of Honesdale), and from that point they had a canal to Rondout on the Hudson. It had been their original purpose to use horse power on the railroad, with stationary engines at the planes (as at present), but the successful experiments with the railroad locomotive in England led them to try that new form and application of power.

"The Stourbridge Lion," as the locomotive was called which "first turned a wheel upon a track in America," was one of three personally ordered by the company's civil engineer, Horatio Allen, in England. The "Lion" was built by Foster, Rastrick & Co. at Stourbridge, and the other two were built by Stephenson, who extended many courtesies to the American engineer. Thus it happened that early in 1828 the first order placed in England for locomotives, after the successful working of those on the Stockton & Darlington road, was from far-away America.

The "Stourbridge Lion" arrived on the ship John Jay, and was landed at the West Point Foundry Company's wharf at the foot of Beech street, New York, where it was set upon blocks and given a trial on June 11, 1829, as appears from the *Morning Courier and New York Enquirer* of June 12, which, after describing the test, says: "We were delighted with the performance of the engine, and have no doubt but that the enterprising company to whom it belongs will reap a rich harvest for their enterprise and perseverance.'' It was noted as a matter of interest, because anthracite coal was then being introduced to the public, that the locomotive was fired with that substance from the Delaware & Hudson Company's Lackawanna mines. It was to put this coal in the market that the company's operations were inaugurated and carried on, and hence may be noted the significant fact that we are indebted to coal mining for the advent of the locomotive, in America as in England.

Great interest was manifested in New York in the marvelous mechanical importation, but it was not comparable with the curiosity and eager expectation into which the people of Honesdale and the surrounding country were thrown by the arrival of the "Lion."

The trial trip of the "Lion" was the talk of the country for a hundred miles around, so that when it came off, on August 9, 1829, a great crowd of people was present at the forks of the Dyberry, which locality, by reason of what occurred there then, is entitled to be considered one of the historic spots of America. A few of the people who witnessed that remarkable display of the first railroad locomotive in the world, outside of England, are still among the living.



THE "STOURBRIDGE LION." THE FIRST LOCOMOTIVE PLACED ON A TRACK IN AMERICA.

Its uniqueness and its significance render its recall from threatened oblivion worth while. The demonstration consisted of the running of the curious little machine a distance of about a mile and a half and then back, while the people shouted and hurrahed (after they had recovered from their first mute astonishment) and cannon boomed till the hills echoed.

Great as were the excitement and enthusiasm that day, it is probable that not a single soul in all the throng—even the most sanguinely imaginative one—had any adequate conception of the era that was there and thus inaugurated.

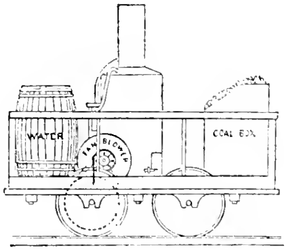
On that momentous occasion Horatio Allen, who had been intrusted with the purchase of the "Lion" and two other engines in

England, was the engineer and sole passenger. He had never run an engine before, and never did afterward, though he lived to be a very old man, had much to do with early railroad affairs, and died only a few years ago. He always took much satisfaction in being the driver of the first locomotive on an American track, but was sorry, in view of some developments, that it was not one of Stephenson's two locomotives, counterparts of the celebrated "Rocket," that made the first trial, instead of the "Stourbridge Lion," as in that case the exploit of the "Rocket" in England would have been anticipated in this country. He never knew until he saw it in a Chicago exhibition in 1883 that the boiler of the "Lion" had not been constructed in accordance with his orders.

The "Lion" was not wholly a success, but was sufficiently so to demonstrate entire practicability. This pioneer of locomotives was of nine horse power. It was a large and cumbrous affair, compared with engines of the same power in the present day. It was without a cab. The cylinders were upright, and a walking-beam on each side communicated the power to the wheels. The locomotive and tender were both four-wheeled, with spokes and felloes of wood, and iron tires and wheel centers. The boiler of this historically-important locomotive is all of it that is now in existence, so far as known, and is, or was until recently, in an iron shop in Carbondale.

Mr. Allen's exhibition of the "Stourbridge Lion" preceded by only a few weeks the Liverpool & Manchester Railway opening and locomotive contest made at Rainhill. America had in various ways anticipated the results of that demonstration of the engine's utility. Her inventive talent was already at work. Horatio Allen, who had come back from England the best informed man in America upon the locomotive, became its chief champion and promoter. He was positive that it was the railway motor of the future. In September, 1829, he went to Charleston to take the position of chief engineer of the South Carolina Railroad. He urged the adoption of steam instead of horse power upon that important road, on the broad ground that there was no reason to expect any material improvement in the breed of horses, while the man was not living who knew what "the breed of locomotives was to place at command."

Under his direction a locomotive called the "Best Friend of Charleston" was built at the West Point Foundry, New York city, and placed on the track November 2, 1830. This was the first locomotive built in America, and the second put upon a track. The South Carolina Railroad, one hundred and thirty-five miles in length, when formally opened in 1833, was the longest continuous railroad in the world.



PETER COOPER'S LOCOMOTIVE, 1829.

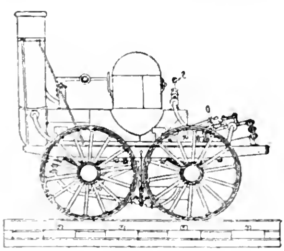
The Baltimore & Ohio Railroad had been commenced in 1828, and in May, 1830, the first section of fifteen miles, from Baltimore to Ellicott's Mills, was opened, but horse power only was employed. As early as 1829 no less a personage than Peter Cooper had experimented with a little locomotive of his own construction upon this line, and in 1875, at Cooper Institute in New York, he related with glee how, on the trial-trip, he had beaten a gray horse harnessed to another car.

Peter Cooper's locomotive was about as large as a hand-car of the present day, and the boiler, the size of a flour barrel, was of the "tubular" variety, the tubes being gun-barrels.

This engine was only a partial success, and in 1831 the Baltimore & Ohio Company, determined to push forward in the employment of steam power, offered the handsome sum of $4,000 for the most approved form of locomotive which should be delivered for trial by June 1, 1831, and $3,500 for the second best, the conditions being that the engine should not exceed three and one-half tons in weight and should be capable of drawing on a level a weight of fifteen tons, inclusive of wagons, at a speed of fifteen miles per hour.

In response to this call, there came the "York," built at Little York, Penn., by Davis & Gartner and designed by Phineas Davis. This product of American genius fulfilled the requirements, and subsequently the same firm built numerous other engines upon a modified plan, which resulted in what was known as the "Grasshopper" locomotives, which were used to some extent on the Baltimore & Ohio Railroad until recently. The "York" appears thus to have been the second practically successful locomotive of American construction.

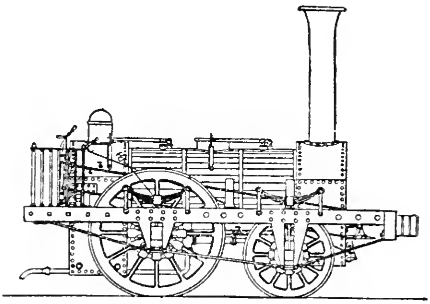
In the same year a notable engine, the "DeWitt Clinton," was turned out for the Mohawk & Hudson Railroad by the West Point Foundry, and made its first successful trip with passengers from Albany to Schenectady on August 9, 1831, drawing what has been very widely and erroneously called the "first railroad train in America,"—for both the South Carolina and the Baltimore & Ohio roads were in operation, with steam power, earlier.


THE DE WITT CLINTON, 1831.

John Stevens and Matthias W. Baldwin were two remarkable men who figured conspicuously and influentially in the early history of the railroad and the locomotive. To the former, who was a locomotive inventor of Hoboken, New Jersey, and had experimented successfully as early as 1826, and to his sons, Robert, Edwin, and John, the projection and building of the Camden & Amboy Railroad were largely due. This accomplishment was fruitful of results, and set in operation a sequence of events very important in the evolution of the locomotive.

It was for this road that the engine "John Bull," built by George and Robert Stephenson & Co., was imported, and it was this little machine that afforded the first object-lesson to Matthias Baldwin, a Philadelphia bookbinder, who was destined to be one of the greatest locomotive-builders in the world.

Stevens, who had witnessed the successful trial of Stephenson's "Planet," had given its builders an order, in 1830, for a locomotive of similar construction, and it was the "John Bull" thus built which duly arrived in Philadelphia and was given its initial trip on the Camden & Amboy road at Bordentown, New Jersey, on November 12, 1831. While the "John Bull" (which was honored with a place in the Columbian Exposition at Chicago) was housed in Philadelphia, and closely guarded from public view, awaiting the trial-trip at Bordentown, Baldwin obtained a view of it, and carefully studied its mechanism. The bookbinder, who was noted as a skilful mechanic and general genius, did this at the solicitation of his friend Franklin Peale, proprietor of the famous Peale's museum in Philadelphia, who, to gratify the intense curiosity of the public on all points concerning the locomotive, wished to place one on exhibition, and desired Baldwin to build it for the purpose. Baldwin, who had already built for his own use a stationary engine, looked the "John Bull" over carefully, and finally announced in a determined way: "I can make it."



THE "PLANET;" AN EARLY ENGLISH TYPE, 1831–35.

Matthias Baldwin's first locomotive, it thus happened, was built as a museum attraction. He produced it after four months of most assiduous labor with his own hands, and with no other aid than his inspection of the English locomotive and a few drawings afforded him. This pioneer Baldwin locomotive, when completed, was put upon a little track making the circuit of the Museum in the old Arcade, and worked smoothly and well, drawing two miniature cars which contained seats for half-a-dozen passengers. Crowds came to see the wonder, and were delighted. It was a pronounced success as a museum attraction, and an educator of the public, and it did much to "boom" the railway idea by making its practicability patent to the popular mind.

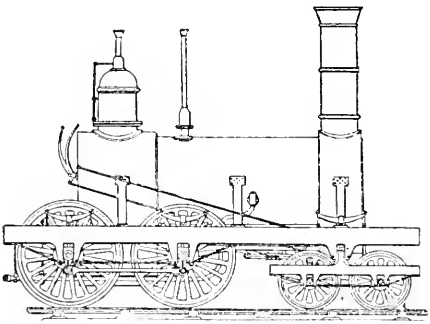
Mere toy as it was,—it weighed only two hundred and twenty-four pounds, including its two-gallon boiler and iron wheels,—it was the start in Baldwin's great career. The success of the museum attraction led to the ordering of a locomotive of Baldwin manufacture by the Philadelphia & Germantown Railroad Company, and the "Old Ironsides" which resulted and was placed on the track November 23, 1832, was one of the most efficient and famous locomotives of the day. The price that Baldwin received for the "Old Ironsides" (the first railroad locomotive built in Philadelphia) was $3,500, which was $500 less than the contract specified. The company came near rejecting it because its weight was nearer seven than five tons; it was thought (though groundlessly) to be too heavy for the track. Had it been rejected, Baldwin would probably never have built another. As it was, he remarked, in accepting the reduced sum, that it was his last locomotive; but he lived long enough to build 1499 more, for at the time of his death the one building at the great works he established bore the number 1500.

After the successful trial of the "John Bull" on the Camden & Amboy Railroad in 1831, a number of locomotives built by the Stephensons were imported from England, most of which were of the class typified by the "Planet," and these furnished in a general way the pattern for those constructed here for a time. But gradually, as new ideas arose, and as the locomotive was adapted, by various changes and improvements, to existing conditions, the American types and patterns became very different from the foreign.

Among the first of these improvements was one in which Horatio Allen, of "Stourbridge Lion" fame, again came to the front, in May, 1831. The axles of the two pairs of wheels, instead of being held inflexibly parallel with each other, were made to turn upon kingbolts, thus greatly facilitating the passage of curves. This principle was afterwards worked upon by John B. Jervis and Ross Winans; was made the subject of extensive litigation by the latter; and was eventually, in an improved form, applied to cars and nearly all of the rolling-stock in the country. From this time onward the history of the locomotive moves fast and is crowded with events. We have already noted the inception of the Baldwin Locomotive Works. It remains to be said that that other great concern, the Norris Locomotive Works, had its origin in March, 1831, in the American Steam Carriage Company, formed in Philadelphia by Col. Stephen H. Long, U. S. A., William Norris, and others; and in 1835 the Rodgers Locomotive Works were started in New York, in a small way, by Thomas Rodgers.

The years 1836 and 1837 are notable in locomotive history as being the dates of two inventions which, more than any others, gave the engine an approach to the appearance it bears to-day. In the former year Henry R. Campbell of Philadelphia patented the use of two pairs of driving-wheels and a truck; and in the latter John Scotti of Baltimore (who died in 1891) invented the locomotive cab, without which any locomotive would appear very strangely to-day.

How rapidly locomotive-building grew in this country is illustrated by the fact that the Baldwin Works finished fourteen in 1835, and forty the succeeding year, and how greatly the mechanical excellence of the machine was enhanced by American genius is indicated by the production in 1836, from the Norris Works, of the "George Washington," so powerful and so scientifically made a locomotive that it performed a feat which American and English engineers had pronounced an impossibility, and took the whole engineering world by storm. It ran up an inclined plane, on the Columbia & Philadelphia railroad, two thousand eight hundred feet in length, with a rise of one foot in fourteen, drawing a load of over nineteen thousand pounds, besides the weight of the engine, at a speed of fifteen miles an hour.



CAMPBELL'S LOCOMOTIVE, 1836.

Significant enough, and forming a typical illustration of American push, is the fact that in the year 1837, only eight years after America had imported her first locomotive, a very satisfactory engine was built for the Austrian government by the Norris Works of Philadelphia. And it was more emphatically demonstrated that America, originally an importer, had become an exporter of locomotives, when in 1839 the Baldwin Works received orders for a large number from railroad companies in England.

It was something of the same spirit and condition of things, manifested in that early day, that has made this country the producer of nearly 2,500 locomotives per annum, and the employer of more than 35,000.

THE ADVANTAGES OF MECHANICAL STOKING.

By A. E. Outerbridge, Jr.

THE brilliant scientific investigations of Tyndall which revealed an intimate and hitherto unsuspected relation between the presence of smoke in the air and the frequent formation of dense fogs in London, supplemented by observations of eminent physicians, and official publications of the board of health of London, showing that pulmonary and other complaints were caused and aggravated by breathing fog and soot intermingled,—in fact, that every dense, sooty fog was responsible for an appreciable increase in the death-rate of the city,—served to arouse public interest in the subject of smoke prevention in England long before it attracted serious attention in this country.

As long ago as 1843 the house of commons appointed a royal commission of fifteen members, including the lord mayor of London, to investigate the subject of smoke prevention.

This commission summoned and examined more than a score of chemists, metallurgists, physicians, and manufacturers, among whom appear the familiar names of Faraday, Ure, Brande, and other distinguished specialists of the time. The metropolitan police were provided with inspection cards, upon which they recorded the character, density, etc., of smoke discharged from hundreds of factory chimneys. The results of the observations made were elaborately tabulated, and illustrations were drawn by an artist showing groups of factory chimneys all pouring forth clouds of smoke. These exhaustive investigations were printed by order of the house of commons, and form a large official volume, a copy of which (perhaps the only one in this country) may be found in the library of the Franklin Institute.*

* The witnesses were examined upon the following questions, and the conclusions of the committee are given herewith :

I. Whether it is practicable to prevent, or diminish, the nuisance now so severely felt in large towns and populous districts from the smoke of furnaces or of steam engines?

II. Whether, if this were practicable, it would be advisable to take any steps to prevent the nuisance, as so doing might interfere with the property or interests of manufacturers. or of the proprietors of furnaces?

III. In the event of the two former questions being answered in the affirmative, would you recommend some legislative enactment to be framed to prevent the nuisance of smoke?

The consensus of opinion of the scientific and practical men, including master manufacturers, was that smoke, which is the result of imperfect combustion, may in all cases be diminished, if not entirely prevented. The report says: "The evidence before your committee further shows that the admission of atmospheric air, under proper regulations, into the furnace is productive of saving in fuel, by causing the particles of carbon, which would otherwise rise in smoke and be wasted, to ignite, and thereby to increase the heat in the boiler."

In conclusion, the committee recommended that a bill should be brought into parliament at an early period of the next session, to prohibit the production of smoke from furnaces and steam engines.

In the early days in America, when factories were situated in sparsely-settled districts and fuel was cheap, the importance of smoke consumption was not as apparent as it is to-day. The subject has now attained prominence largely by reason of municipal regulations which have been passed in many cities (and are about to be enforced) restricting the pollution of the atmosphere by smoke from soft coal and instituting fines and penalties therefor.

The citizens of Pittsburg were afforded a grand object-lesson, during the reign of natural gas, by the increased comfort, cleanliness, and healthfulness of the city resulting from the substitution of clear atmosphere for the smoky pall in which they were formerly, and are now again, to some extent, enveloped.

Very recently Mr. F. W. Duenckel, the observer in charge of the Forest Park meteorological observatory near St. Louis, contributed some interesting information to the discussion of the smoke nuisance in that city. Noticing that there were, at times, greater differences between temperature readings at his station and those at the United States weather bureau in St. Louis than were warranted by the intervening distance of $4\frac{1}{3}$ miles, Mr. Duenckel plotted the readings for some years. In calm weather the smoke from factories hangs over the city, preventing radiation and consequent cooling at night, and refracting the sun's rays during the day. This interference with radiation Mr. Duenckel considers detrimental to health, to say nothing of the injurious effect of the carbon in the atmosphere.

The city of St. Louis passed an ordinance [17,049] in 1893 declaring the emission of dense black or thick grey smoke to be a nuisance, and providing for the suppression thereof. It was further ordained by the municipal assembly as follows:

Section I. "The president of the board of public improvements is hereby authorized and directed to appoint, with the approval of the mayor, a commission composed of three competent persons, who shall not be directly or indirectly interested in the manufacture, sale, or construction of any furnace or other article having practical relation to the production or prevention of smoke. Said commission shall ascertain by a thorough canvas of the city, and report to the board of public improvements, within four months after their appointment, the conditions and liabilities under which manufacturing, and other parties, cannot wholly or reasonably prevent the occasional production of dense visible smoke. Such ascertained conditions and liabilities, when approved by the board of public improvements and mayor, shall be published, and thereafter shall constitute instructions to guide and limit the officials charged with the enforcement of smoke-suppression ordinances. And it shall be a valid and sufficient defence against any complaint that the offence charged comes within such recognized conditions and liabilities.

In accordance with this provision a smoke commission was appointed; the members were Messrs. Wm. B. Potter, Wm. H. Bryan, and Wm. McClellan. The report of this commission, approved by the mayor of St. Louis, was published in pamphlet form, and is before the writer. It appears that the various boiler plants and all other kinds of furnaces and smoke-producing fires were classified, and a sufficient number of types in each studied in detail to secure the data necessary to the formation of a proper judgment in any individual case. It was found that, "notwithstanding the many variations in type of boilers and of setting, and of kind and conditions of service, occurring in the city, and in spite of numerous instances of defects in construction, arrangement of accessory parts, or in location, there are very few cases where the conditions and liabilities are such that some means cannot be employed successfully to wholly or reasonably prevent the production and emission of dense visible smoke."

Exceptions are noted, as in the case of certain metallurgical operations where reverberatory furnaces are used, requiring a neutral smoky flame in the hearths for a successful product; also in kilns for burning brick, tile, sewer-pipe, pottery, muffle and tinning furnaces, etc. In these cases certain suggestions for improvements are made, and it is stated that, in puddling, re-heating, annealing, steel-melting, and ore-roasting furnaces, the character of the heat applied is such that any change with a view to abating the smoke produced would seriously interfere with the working of the furnaces, "constituting for the present a valid and sufficient defence against any complaint of violation of ordinance No. 17,049 on the part of any company through the operation of the above-named furnaces."

An appendix contains a description of the methods of testing smoke-abatement devices, giving "general plan," "weighing and measuring coal, ash, and clinker," "water," "heating surface," "horse power," "gas analyses," etc.*

The meteorological records of the superintendent of the Forest Park observatory, near St. Louis, indicate that the smoke-abatement ordinance has not as yet been generally observed, but it is doubtless wise forbearance on the part of the authorities to allow sufficient time to elapse to thoroughly test the efficiency and durability of various smoke-consuming appliances which have been installed since the passage of the ordinance.

New Orleans, Cincinnati, and other cities passed laws relating to

* The ordinance [17,049] referred to reads:

"Be it ordained by the municipal assembly of the city of St. Louis as follows. The emission into the open air of dense black or thick grey smoke within the corporate limits of the city of St. Louis is hereby declared to be a nuisance. The owners, occupants, or agents of any establishment, locomotives, or premises from which dense black or thick grey smoke is emitted or discharged shall be deemed guilty of a misdemeanor, and, upon conviction thereof, shall pay a fine of not less than ten nor more than fifty dollars, and each and every day wherein such smoke shall be emitted shall constitute a separate offence. This ordinance shall take effect at the expiration of six months after approval by the mayor." Approved February 17, 1893.

smoke discharge many years ago, but they have been ignored. The St. Louis ordinance, which was carefully prepared, and is about to be enforced, is, therefore, chosen as a representative of restrictive legislation. Within the past year Pittsburg has passed a similar ordinance "to regulate and suppress the production and emission of smoke from bituminous coal, and to provide penalties for the violation thereof."

Inspectors have been appointed, provided with rules and appliances for approximately determining the amount of smoke discharged daily from factory chimneys. Other cities are adopting the same restrictions, and it is evident that the time is now approaching when this problem must be solved, either by the voluntary action of the manufacturers, or by law. The attention which is being devoted to discussions of the smoke nuisance in the engineering magazines and other technical papers further proves that this is a live issue to-day.

It may be accepted as a fact that the discharge of soot, or unconsumed fuel, from a chimney is a nuisance, destructive to the neighboring property and detrimental to health. The question then logically follows: "Is it possible and practicable to economically consume smoke under boilers?" *

Granting such possibility, are the appliances durable, and are they equally adaptable to externally- and internally-fired boilers?

The fact that several thousand boilers of different types are daily fed by mechanical stoking appliances, and that the number is increasing rapidly, points to an affirmative answer, and it does not seem hazardous to predict that the majority of large boiler plants using bituminous coal will be equipped with automatic stokers within a few years.

An article in the *Iron Age* (March 5, 1896), entitled "Smoke-Consuming Appliances and Smokeless Powders," revealed an unexpectedly close relationship between these two lines of investigation, and it is interesting to note that smokelessness of powder for modern guns "came as an unsought factor, but an inseparable one. Higher power means complete combustion, and complete combustion means smokelessness." It is shown by Colonel Farley that a flatter trajec-

* "Within the corporate limits of the city of Chicago there are located fifteen thousand steam boilers, of which not less than twelve thousand are consumers of soft coal. These are scattered over one hundred and eighty-six square miles of territory. No two plants are alike, and in almost every case which comes under the inspection of the smoke bureau there are special defects to be overcome. . . . . The maintaining of the smoke nuisance in the down-town district is an inexcusable outrage. . . . . I know of an instance in which a restaurant firm so consumed $600 worth of coal as to cause an actual damage to adjacent property exceeding $25,000. In another instance an apartment building under the management of a receiver, protected by the court against the enforcement of the smoke ordinance, ruined the furniture and furnishings of every residence for two blocks in its neighborhood, and depreciated the value of adjacent real estate more than one-third of the former value." *Report of Chief Smoke Inspector F. W. Adams. Published in the annual report of the department of health of the city of Chicago, 1894.*

tory, increased range, greater velocity, greater penetration, and decreased weight of powder in cartridges have resulted from the perfect combustion of smokeless powder. The paper states that "no more convincing argument as to the increased efficiency resulting from perfect combustion could possibly be offered than the experiments with smokeless powders. They are accurate quantitative analyses of combustion of fuel."

No one realizes more fully than the analytical chemist the difficulty of obtaining complete combustion of carbon. It seems an easy matter to thoroughly burn a few grams or grains of powdered carbon in an open platinum vessel when subjected to a white heat; yet such an operation is a tedious one, often consuming hours, and sometimes requiring the use of powerful oxidizing agents. It is not surprising, therefore, that a large percentage of unconsumed carbon passes off from an ordinary furnace, and the fact that bituminous "slack" can now be continuously fed into a fire-box without visible smoke appearing from the chimney-top is a fine testimonial to the mechanical excellence of appliances which so closely approximate the perfection of laboratory apparatus and methods. There are several forms of mechanical stokers designed to practically accomplish this result; but complete combustion does not necessarily mean economical practice. An excess of air over the exact amount required facilitates combustion, but also causes loss of heat energy. The atmosphere, being a mixture of 23 parts of oxygen with 77 parts of nitrogen, will quickly rob the furnace of its heat, if too freely admitted to the burning fuel.*

The well-established rules governing the amount of grate surface, proportion of fuel per square-foot of grate surface, etc., require to be carefully observed in designing mechanical-stoking appliances. Economy of fuel is not the most important consideration in mechanical stoking; in large plants the saving of labor is a much larger item, amounting (according to the calculations of experts who have studied the subject) to fifty per cent., or more, in some cases.

Economy of fuel in successful mechanical stoking results not solely or chiefly from combustion of smoke, but from the more uniform feeding of "green" coal to the furnace, entirely avoiding the opening of fire doors, with consequent drop of steam pressure, etc. Incidental advantages and economies, such as prolonged life of boilers due to regular firing, etc., are claimed by makers of mechanical stokers, and, if there were no offsetting disadvantages, the use of such appliances

* To find the quantity of air at 62° F. under one atmosphere chemically consumed in the complete combustion of one pound of a given fuel, and to ascertain the quantity of surplus air that enters a furnace, see "Manual of Rules, Tables, and Data for Engineers; by Daniel Kinnear Clark" p. 400 *et seq.*

would, presumably, be universal instead of exceptional. The cost of an effective and durable mechanical-stoking plant limits its application, and the uncertainty as to the actual economy has hitherto further retarded the general introduction.

Economy of operation depends upon many details of construction: (1) every part of the machine must be readily accessible for repair; (2) the mechanism must be sufficiently simple to be operated by a man of ordinary intelligence, without frequent supervision; (3) the feeding of fuel must be at all times under perfect control of the attendant, so that the fires may be checked or augmented as desired; (4) automatic arrangement for continuously feeding the coal in a thin, even layer, over the entire grate-bar surface, and for constant progressive movement of the body of fuel to prevent formation of clinker, must be provided; (5) the grate bars and other parts of the mechanism which are subjected to heat must be designed to resist distortion, burning out, and other causes of rapid deterioration; (6) the stoker must be adapted to the use of cheap fuel.

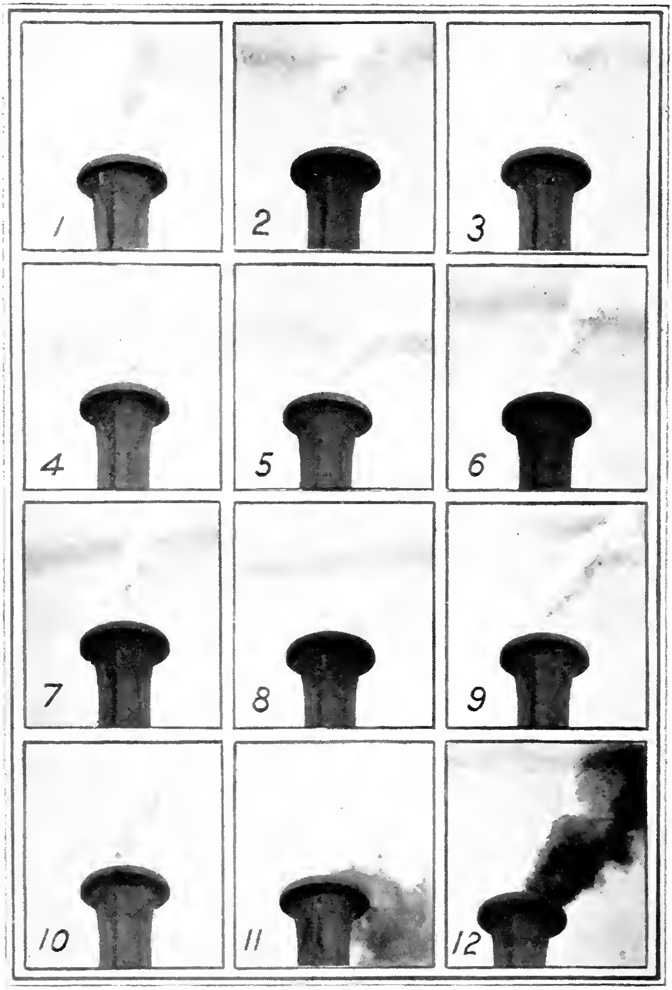
These are the essential qualifications of all successful stokers; there are other features which, though less necessary, add to the utility and convenience, and thus distinguish one form of stoker from another. The possibility of smokeless combustion is clearly shown to be only one factor in the determination of the relative merits of different forms of mechanical stokers. It is, indeed, possible by careful hand-firing, in well-designed furnaces, provided with combustion chambers, dampers, or other appliances for regulating the supply of air, and by constant intelligent supervision, to burn soft coal with comparatively little discharge of black smoke from the chimney; and one of the indirect beneficial results of the introduction of successful mechanical stokers in large boiler plants will, doubtless, be an improvement in methods of hand-firing in small establishments which cannot afford the expense of a mechanical-stoking outfit. Thus one installation of a practically successful mechanical stoker in any manufacturing locality serves a double purpose, and the several cities which have passed ordinances regulating smoke discharge are wisely taking the initiative by introducing complete mechanical-stoking appliances at the public boiler plants. It is apparent from the foregoing broad statement of principles of mechanical stoking that durability of machinery and economy of operation are far more important considerations in any appliance of this character than the mere question of first cost.

The principle upon which the mechanical stokers operate is extremely simple. There is usually a hopper or receptacle into which the coal is thrown, either by shovelling or by conveyors; the coal is pushed forward by a continuous or an intermittent movement, into the furnace upon the grate-bars : these are sometimes provided with reciprocating motion, and sometimes made in the form of an endless chain. The coal is spread by various devices more or less evenly, and gradually travels toward the back of the furnace, where a combustion chamber is often provided to complete the burning of the fuel and gases. In some forms the coal is fed underneath the bed by a "worm" or other conveyor, and pushed up through the burning mass at proper places.

Some forms of stokers are adapted to bituminous or coking coal, and others to anthracite fuel. Some are adapted for externally-fired boilers only, others for internally-fired boilers, while still others may be modified to suit varying conditions.

A striking proof of the practicability of complete combustion of smoke, even when feeding bituminous slack, by means of an automatic mechanical stoker, is afforded in the illustration on the next page, showing twelve photographs of the top of a foundry stack, taken at intervals of two minutes apart, at a time when the stoker was feeding 35 pounds of bituminous slack per square foot of grate-bar per hour, to the furnace of a boiler and developing over 200 h. p. Nos. 1 to 10 inclusive show the results with the mechanical stoker working under usual conditions, the only visible escape from the chimney being that of steam from an engine exhaust-pipe which had no connection with the stoker. At a given signal the automatic stoking appliance was cut out, the fuel added, and the fire raked by hand. The smoking capabilities of the fuel were immediately exhibited by the emission of dense black smoke from the chimney top (as shown in Nos. 11 and 12), which continued to pour forth until the mechanical-stoking apparatus was again put into operation, when the smoke was immediately and entirely consumed.

It would seem unwise, or inappropriate, in a paper which aims to give a general and impartial view of the advantages of mechanical stoking over hand firing, and to present briefly the fundamental principles underlying the construction and operation of all successful appliances of this character, to discuss the relative merits of different forms of stokers. It would be difficult, if not impracticable, to cover the whole field, and there would be danger of doing some one unintentional injustice by an oversight or omission. For the foregoing reasons it is deemed preferable to confine this paper to the historical and general treatment of the subject. All of the statements here made tend to prove that the time is approaching, if indeed it has not already arrived, which was clearly anticipated by a former generation,—a time when the intolerable smoke nuisance in cities where soft coal is used must be abated, if not entirely suppressed. It appears, moreover, that mechanical appliances for accomplishing this object have now been so far



perfected that the one-time fear that smoke ordinances would prove impracticable, or, would, at all events, impose hardship upon manufacturers, no longer obtains: on the contrary, it is more than probable that self-interest will lead large industrial establishments to adopt, voluntarily, smoke-consuming appliances as soon as the many advantages of mechanical stoking are made manifest. The object of this paper is to further that end.

THE ARCHITECTURE OF OUR GOVERNMENT BUILDINGS

By Wm. Martin Aiken.

THERE has been no period in the development of this country (certainly not since the agitation of the slavery question) when the people at large have taken so deep an interest in national affairs as now. And this interest is not exhausted in questions which are decided by the ballot, or by the executive, judicial, or legislative branches of our government, but extends to every department which in any manner contributes to the material welfare, importance, or dignity of the country. This general and sincere appreciation of public affairs is certainly one of the strongest proofs of the stability and permanency of our institutions.

There is, under the control and direction of the secretary of the treasury in Washington, an office which supplies a certain stimulant to this interest, since with it originates, and through it is materialized, the " local habitation " for many government officials in every one of these United States,—namely, the office of the supervising architect.

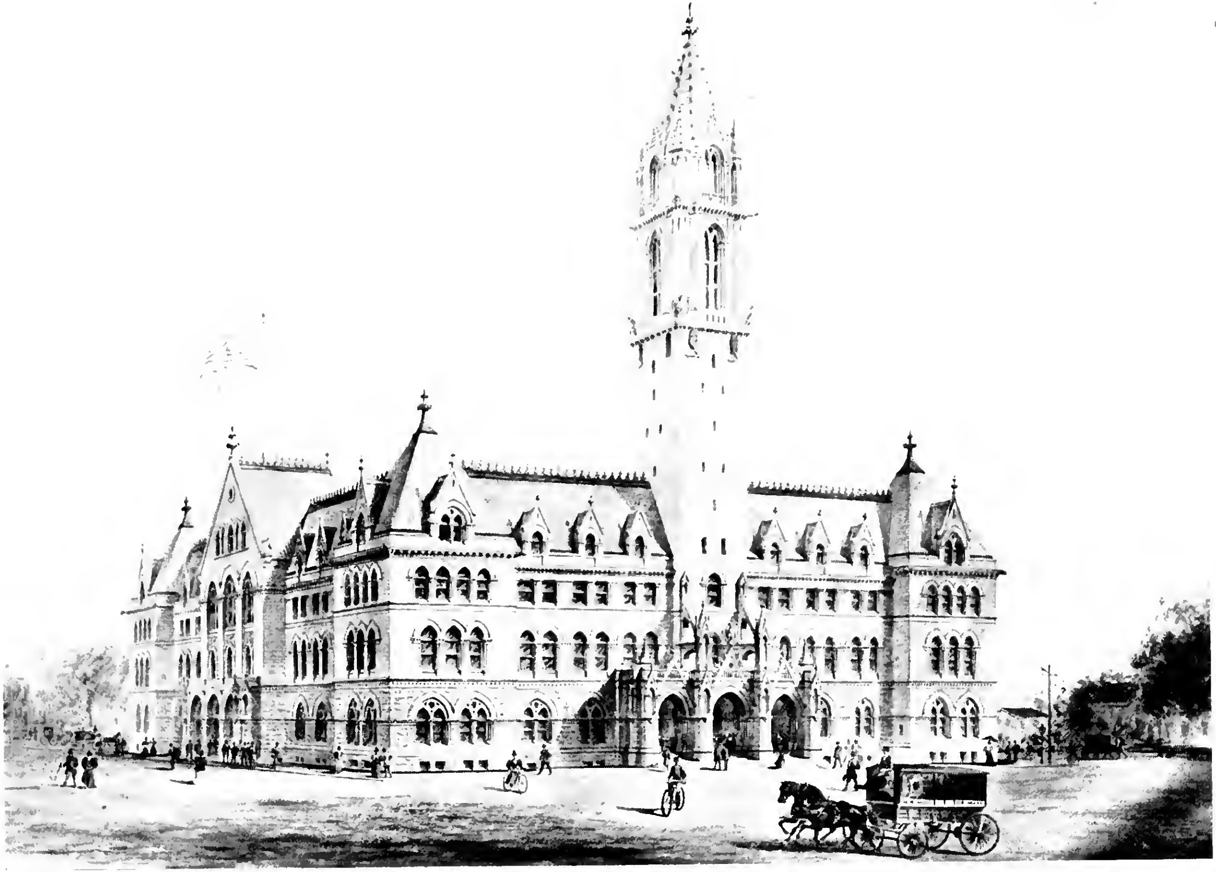
It has been constantly asked why this bureau of construction should be a branch of the treasury department. It should be remembered that our country has not always been so large, so densely populated, or so well acquainted with its own resources, as it now is. When, in 1853, Secretary Guthrie undertook to organize such a bureau and made application to the secretary of war " for a scientific and practical engineer," to Capt. Alexander H. Bowman, of the engineer corps of the army, was entrusted the duty of providing for the repair and preservation of 23 buildings belonging to the government and of supervising the designing and construction of 15 more for which congress had made appropriations, whereas at present 316 buildings, completed and occupied, are in charge of the supervising architect, to say nothing of 66 more, the construction of which has been ordered by congress. In those days the duties were confined mainly to the making of plans and estimates for custom-houses, mints, and marine hospitals, and the general superintendence of their construction. Since custom-houses were intended for the use of collectors of the government income, and mints for the coinage of currency, it was but natural that the secretary of the treasury should control their erection. By degrees the construction of appraisers' stores, post-offices, court-houses, and quarantine stations have been added to the duties of this office. In 1863 the annual report was made by Mr. Isaiah Rogers, who seems to have been the first officer to subscribe himself as "Supervising Architect," and who previously had been employed to design the custom-house at Boston and certain other government buildings.

The incumbents of the office up to the present time have been the following:

Isaiah Rogers,	appointed	June 10, 1863.
A. B. Young,	"	1865.
A. B. Mullett,	"	May 29, 1866.
Wm. A. Potter,	"	January 20, 1875.
James G. Hill,	"	August 11, 1876.
M. E. Bell,	"	November 10, 1883.
Will. A. Freret,	"	July 21, 1887.
James H. Windrim,	"	March 28, 1889.
W. J. Edbrooke,	"	April 20, 1891.
Jeremiah O'Rourke,	"	April 20, 1893.

As the duties of the office have increased, so also has its organization been extended, subdivided, and combined, until now there are eight divisions. Two of these (the law and records division and the accounts division) are under the special charge of the chief executive officer, Mr. Charles E. Kemper, who, from September, 1894, to April, 1895 (the interim between the resignation of the last and the appointment of the present supervising architect), administered the affairs of the office, and, under the guidance of the secretary and assistant secretary of the treasury, was able to effect certain changes and modifications which had long been desired by every previous holder of the office. The result of this reorganization relieves the architect of the actual supervision of clerical work, and permits him to devote his time and attention to the other six divisions. These are known as: (1) the engineering and drafting division (where the designs are made and the construction laid out); (2) the computing division (where estimates of cost and specifications governing construction are made); (3) inspection and materials division (which issues instructions to, and receives reports from, superintendents, and directs the movements of special inspectors who visit buildings in progress of construction or repair); (4) repairs division; (5) photographing division (which reproduces by photographic process the drawings required for works of construction or repair); (6) the tracing division.

Thus it may be seen at a glance that, although the general public is under the impression that the majority of the employees of this

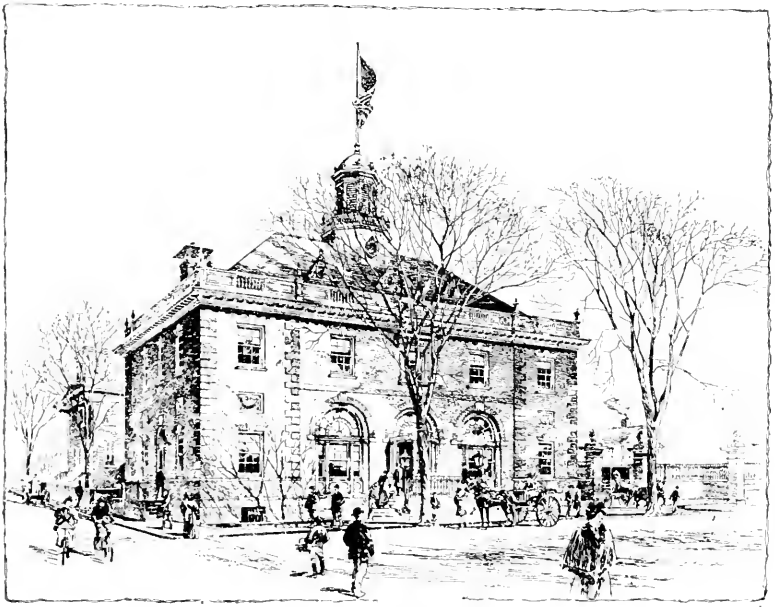


POST-OFFICE AT BUFFALO, N. Y. GOTHIC TYPE, MASSES SIMPLE AND FORMAL; ORNAMENT CONCENTRATED.

office are draftsmen, as a matter of fact these constitute less than one-third of the total number employed, the execution of the work requiring the services of many stenographers, typewriters, and other assistants. In addition to the files of correspondence, reports, specifications, contracts, deeds (of property purchased), etc., there are also files of all kinds and descriptions of materials submitted by contractors for use in the construction of the buildings, such as stone, marble, brick, terra-cotta, tiles, wood, hardware, plumbing-fixtures, etc. The initial movement towards the erection of a government building is the framing of a bill by one or more members of congress from that section of the country in which the proposed building is to be located, which bill is formulated upon information received from officials of the various departments contemplating the occupation of such building, together with the approximate estimate of cost furnished by the supervising architect. This bill then undergoes the scrutiny of the committee of public buildings and grounds, as well as that of the appropriation committee of both houses, after which, to become a law, it must receive the approval of the president.

A portion of the appropriation is set aside for the purchase of the site, and, after it has been purchased, and the title has been approved by the department of justice, and the property rights have been vested in the government, the preliminary drawings and estimate are prepared for the signature of the secretary of the treasury, postmaster-general, and secretary of the interior, whose approval is required by law before any working drawings can be made. The supervising

POST-OFFICE, BEAVER FALLS, PA. STYLE SUGGESTIVE OF NORTHERN CENTRAL EUROPE, ADAPTED TO AMERICAN CONDITIONS.



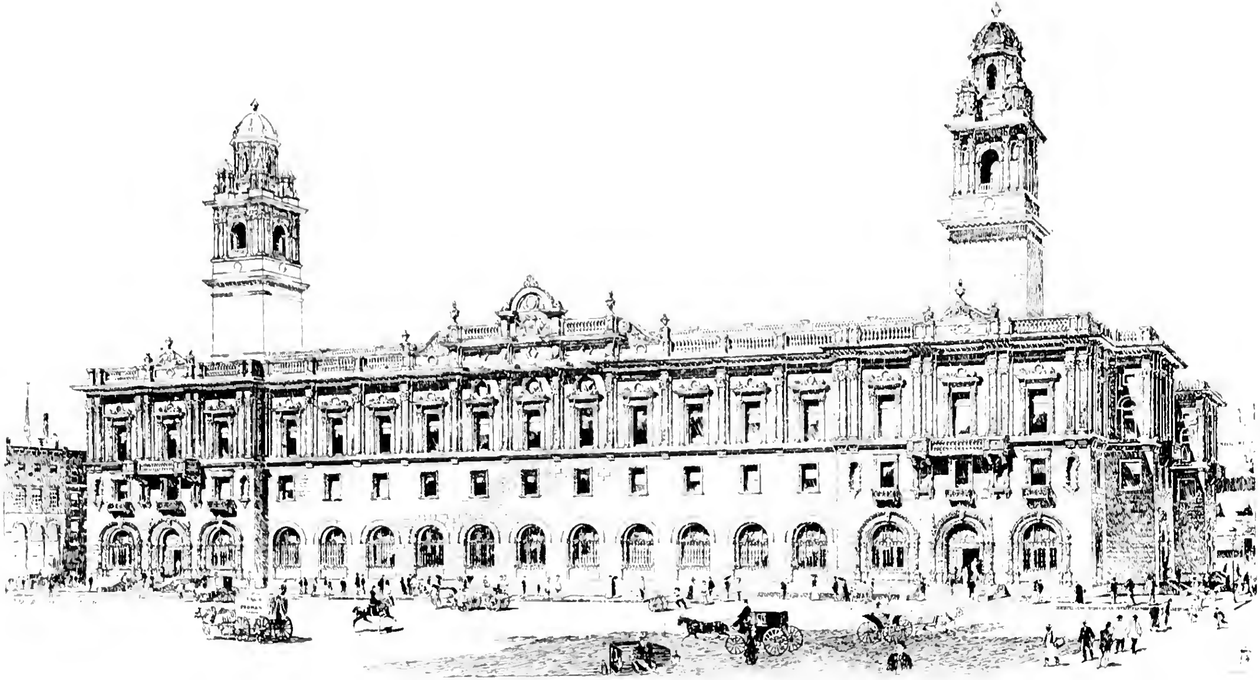
POST-OFFICE AND CUSTOM-HOUSE, NEW LONDON, CONN. OLD COLONIAL TYPE OF NEW ENGLAND.

architect has, in the mean-time, visited the site, in order that the design may conform as accurately as possible to the requirements of the purposes for which the building is intended, and that the environment may be given proper consideration. The influences which now chiefly affect the character of the design proceed from causes climatic, geological, and historical,—relations which have always existed between local conditions and logical design, even from prehistoric ages and in every part of the world. Thus, within that portion of our country to the north of the isothermal line extending from Cape Hatteras, and to the east of the Missouri river, the roof is generally given a steeper pitch, to shed more quickly the heavy rains or snows, as shown in the designs for government buildings at Buffalo, N. Y., New London, Conn., Paterson, N. J., Beaver Falls, Pa., Madison, Ind., Richmond, Ky., Clarksville, Tenn., and Saginaw, Mich. For buildings situated to the south of that mysterious North Carolina line, and to the west of the Missouri river, roofs of gentler slope are indicated, the rainfall requiring less consideration and the radiation of the sun's rays more, as in the designs for buildings at Meridian, Miss., Pueblo, Col., Denver, Col., San Francisco, Cal., and Portland, Ore. Those who have visited Italy can appreciate the importance—yes, the absolute neces-

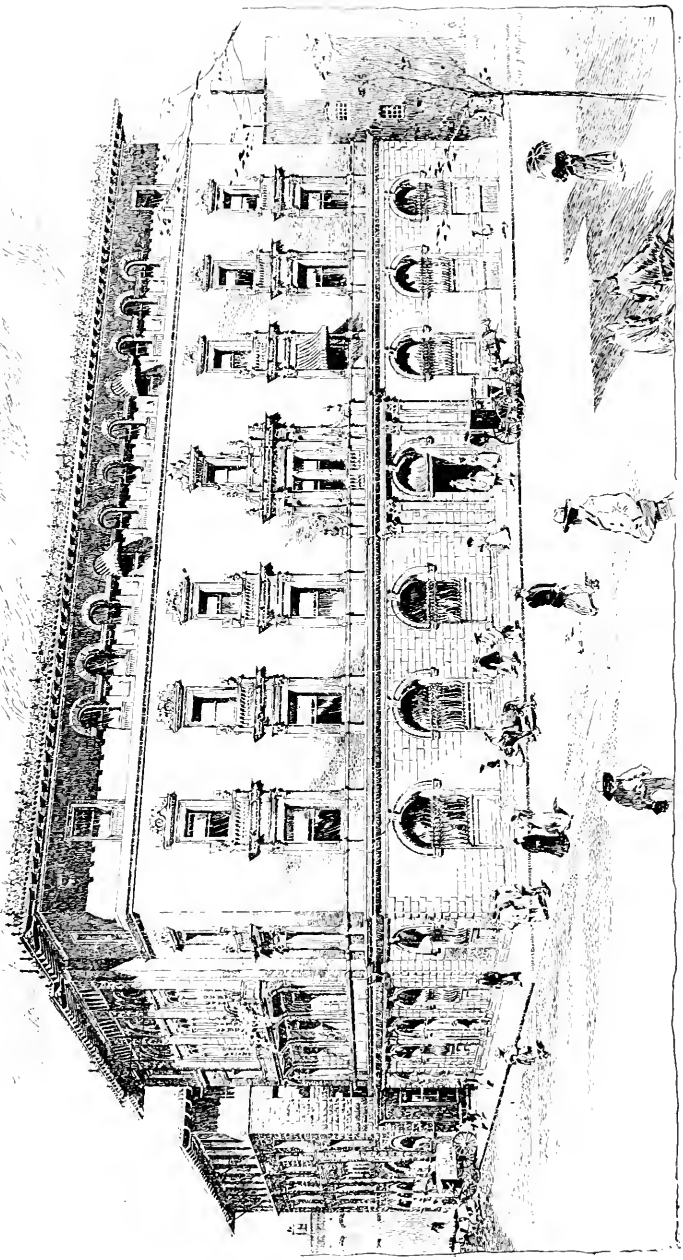
POST-OFFICE, RICHMOND, KY.

sity—of sunshine for the enjoyment of life in that land, and in "Our Own Riviera" Mr. Howells has indicated with his inimitable touch many subtle distinctions produced by differences between the climatic conditions of the Atlantic and Pacific slopes. In the government buildings about to be erected at San Francisco, and at Portland, Ore., this has been recognized in plan as well as in elevation, the former having a U-shaped and the latter an H-shaped plan, with no interior light-shafts, all rooms receiving light and air directly from without.

The legend "*E Pluribus Unum*" indicates that we are a nation of many peoples, and this sentiment is given proper weight in the historical influences affecting the design of our national edifices. The



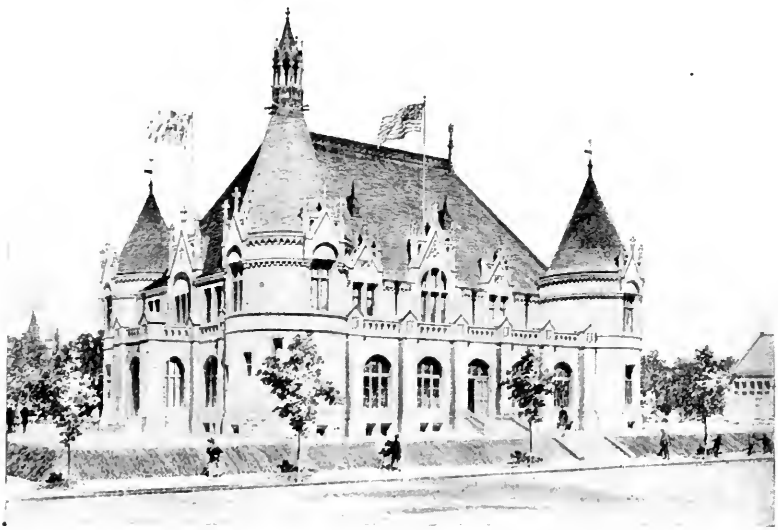
POST-OFFICE AND COURT-HOUSE, SAN FRANCISCO, CAL. SPANISH STYLE ADAPTED TO BUILDING OF LARGE SIZE.



POST-OFFICE, PUEBLO, COL. ADAPTATION OF SPANISH STYLE TO A BUILDING OF MODERATE SIZE.

post-office and court-house in San Francisco is to be built on Seventh and Mission streets, and will contain the old Spanish records of a State or city whose early history has a decidedly Spanish flavor. Not only the primitive adobe buildings still seen and used, but the very name of the city, proclaim the origin of Pueblo, Colo.: what, then, more logical than the adaptation of the Spanish style of architecture to the buildings in these cities?

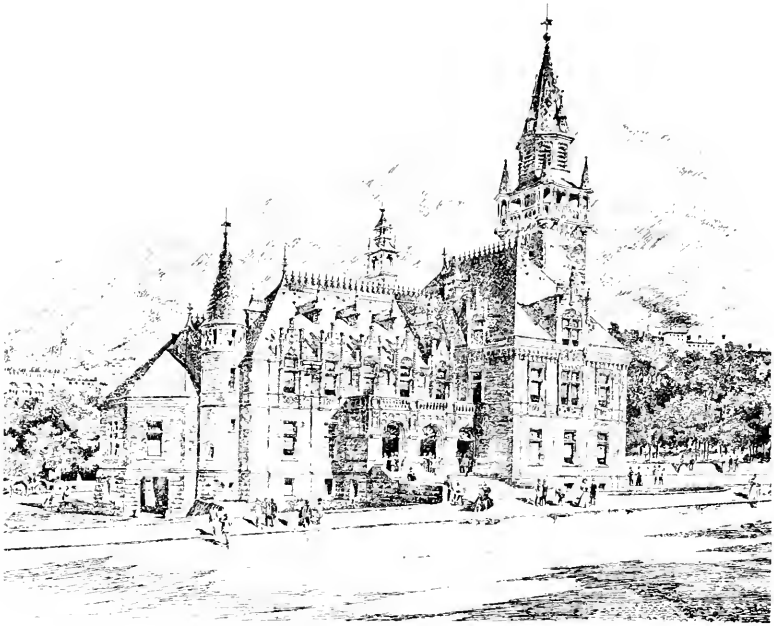
In a publication entitled "The County of Saginaw," by Wm. H. Sweet (May 26, 1896), is the following statement: "The first settlers in the valley located therein in 1815; they were mostly of French origin or half-breeds; their avocations chiefly trading with the Indians,



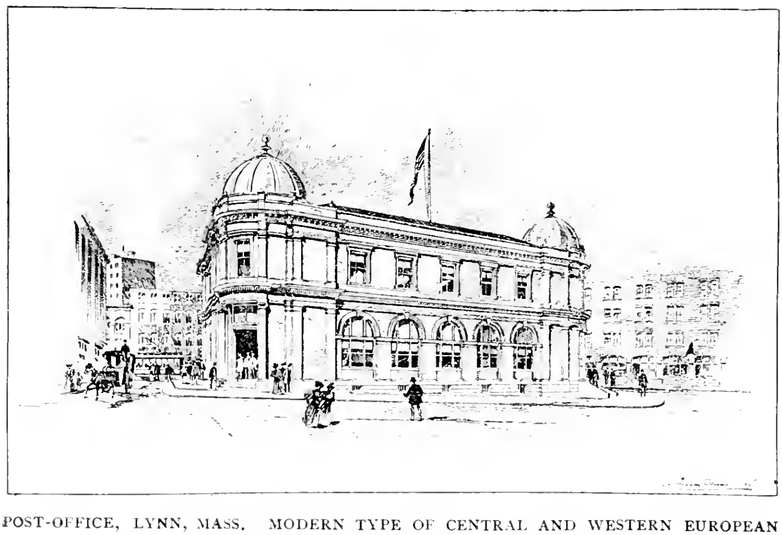
POST-OFFICE, SAGINAW, MICH. SUGGESTING FRENCH TRADITIONS. STYLE OF A CHATEAU OF THE VALLEY OF THE LOIRE.

hunting, and fishing." The post-office in Saginaw is accordingly French in style, the corner towers being suggestive of the defensive feature of frontier life, while the carving of the pinnacles and finials was suggested by the fauna and flora of the neighborhood.

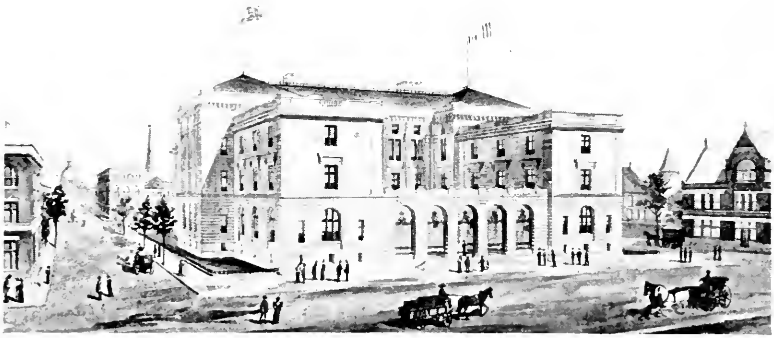
Among the earliest settlers of Paterson, N. J., were a number of Flemish silk-spinners and weavers, so that, in the course of time, the silk industry grew to be a very important one; the post-office in that city, therefore, suggests, in the style of its architecture, the nativity of its first substantial citizens. In the buildings at Pawtucket, R. I.,



POST-OFFICE, PATERSON, N. J. FLEMISH TYPE OF PICTURESQUE URBAN ARCHITECTURE.



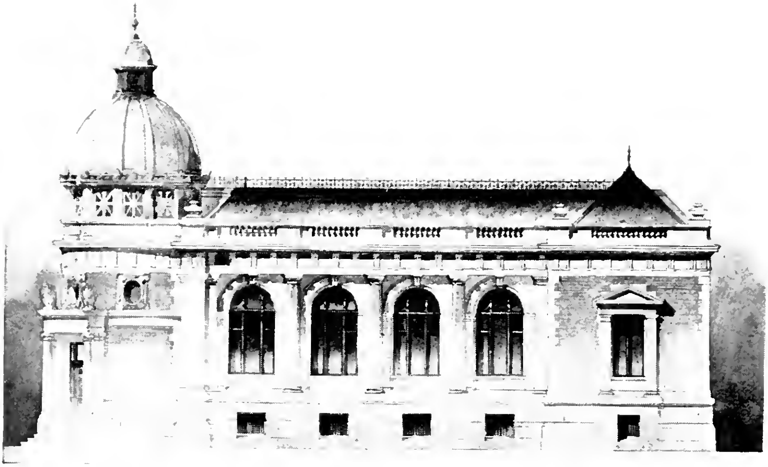
POST-OFFICE, LYNN, MASS. MODERN TYPE OF CENTRAL AND WESTERN EUROPEAN CIVIC ARCHITECTURE FOR BUILDINGS OF MODERATE SIZE.



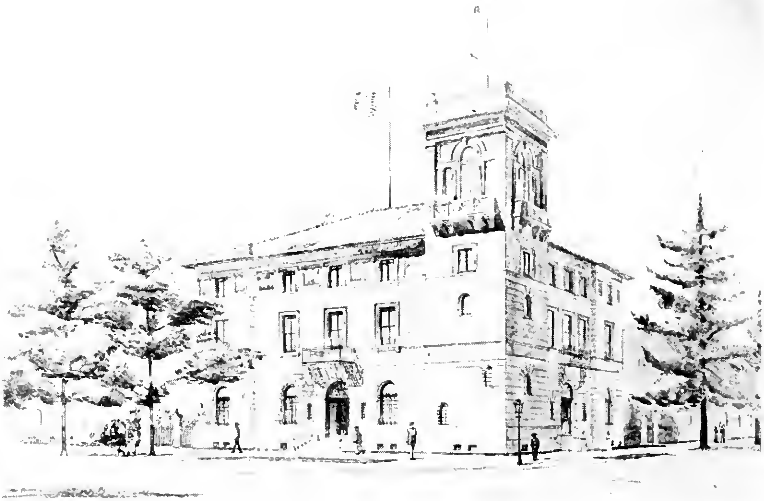
CUSTOM-HOUSE, PORTLAND, OREGON. TYPICAL OF MODERN CIVIC ARCHITECTURE OF CENTRAL EUROPE FOR LARGE BUILDINGS.

and Lynn, Mass., the direct business methods of the citizens, with the academic training of so many communities of that section, have been recognized in designs suggestive of the training which architects receive from the "Ecole des Beaux Arts" in Paris, the most notable school of architecture of the present day, where many of our foremost architects have studied. The mint buildings at Denver and Philadelphia have called for special treatment, the conditions governing each being entirely different, not only from those of other government buildings to be designed and erected at this time, but from those governing the other. These two (and the Portland building) are fortunate in fronting upon wide streets, thus permitting the use of broad and simple motives. A mint, being a money-making building, can

THE MINT, DENVER, COLORADO. STYLE OF THE MEDIEVAL PALACES OF FLORENTINE BANKERS.



POST-OFFICE, PAWTUCKET, R. I. TYPICAL OF WESTERN AND CENTRAL EUROPEAN CIVIC ARCHITECTURE FOR MODERATE SIZED BUILDINGS.

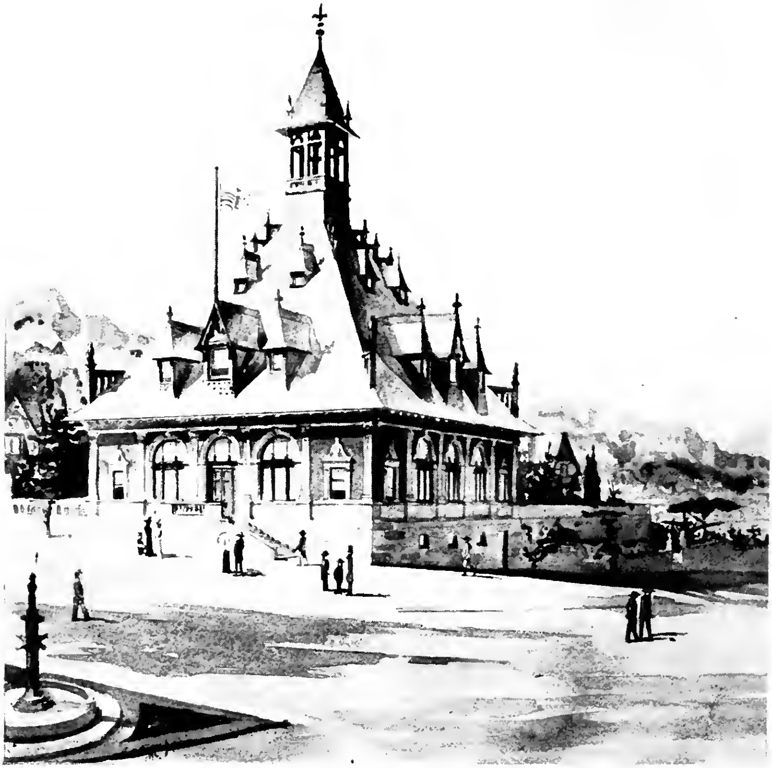


POST-OFFICE AT MERIDIAN, MISS. TYPE OF BUILDING IN ITALIAN STYLE, ADAPTED TO SOUTHERN CLIMATE.

well afford to assume somewhat of an industrial air; yet in these two instances (being situated on the border line between the residential and commercial sections of their respective cities) the surroundings have received special consideration, with a result which may be discernible. Since it is always the desire of the supervising architect to specify such materials as are generally acknowledged by a community to be suitable for building in that locality, the design for the Denver mint recognizes in its motive the sturdy, robust Florentine palace with the possible use of the local red (or gray) granite or the red sandstone, which would show to advantage in the clear atmosphere of Colorado.

THE POST-OFFICE AT MADISON, INDIANA. ROMANESQUE TYPE, ROBUST AND SIMPLE.

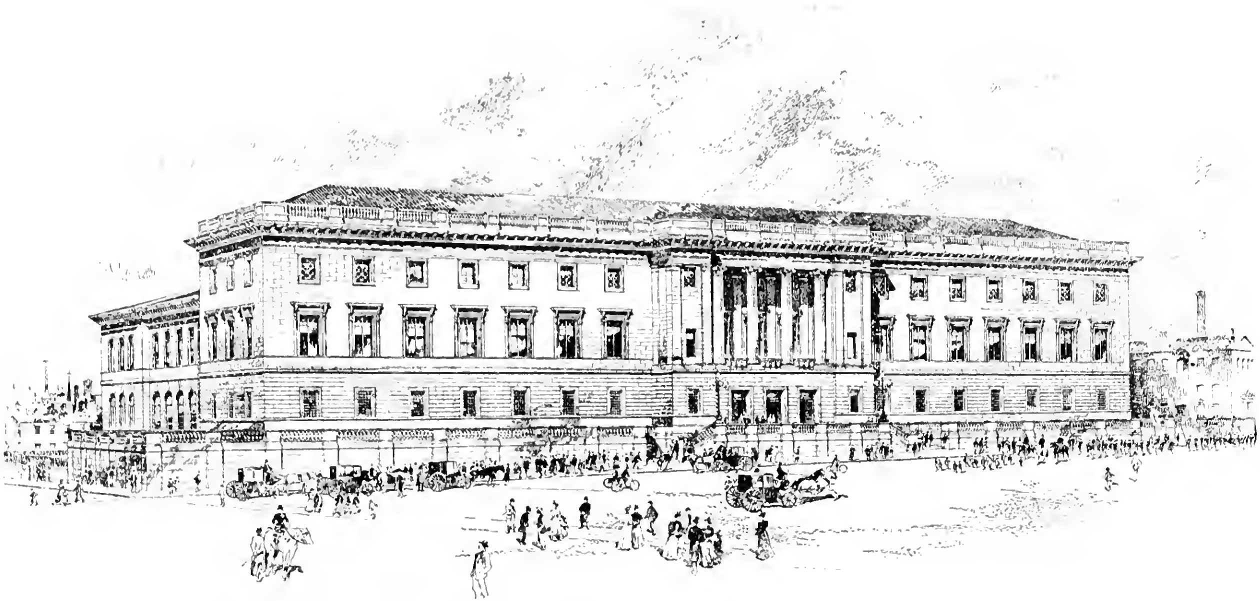
The traditions of the Old Mint and of certain other buildings in Philadelphia have called for the manifestation of a more classical feeling in its successor, leading to the consideration of a white marble exterior. In the Buffalo post-office, court-house, and custom-house,—the largest and one of the most important buildings designed in this office within the past two years,—a mottled pink granite is being used, as the best material obtainable within a reasonable distance; and a rather free treatment of early Gothic has been chosen as the style, being capable of greater refinement than the Romanesque and of greater vigor than the Renaissance. The buildings at Madison, Ind., and Richmond, Ky., are constructed of materials well known in their sections, and it



POST-OFFICE, CLARKSVILLE, TENN. A DESIGN AFFECTED BY THE INFLUENCE OF PICTURESQUE NATURAL SURROUNDINGS.

is hoped that the best quarries of the Pacific slope may furnish stone for the exterior of the buildings now proposed for San Francisco and Portland. It does not often happen that a government building may be consistently picturesque, but in the cases of Paterson, N. J. (where the lot is irregular in shape and there are considerable differences of grades), and of Clarksville, Tenn. (near which runs a broadly sweeping river with precipitous banks in an almost mountainous country), the result could scarcely be otherwise.

Each one of the three influences, climatic, geologic, and historic,



THE UNITED STATES MINT AT PHILADELPHIA, PA. CLASSIC TYPE, CHARACTERIZED BY SEVERITY WITH REFINEMENT.

is often greatly modified by another and very different (but equally important) condition which always confronts the government architect as surely as it does the architect in private practice. This is the element of cost. For instance, although good building stone may be found within reasonable distance of such cities as Lynn, Mass., Saginaw, Mich., or Pueblo, Col., yet the appropriation authorized by congress for the construction of the building may not be sufficient to warrant the use of stone for the entire building, and the architect must adapt his plans to the funds available. The resulting modification in the selection of material, such as the use of brick with trimmings of stone or terra cotta, must affect the character of the design, and, as granite is a more expensive as well as a more intractable material than sandstone, limestone, marble or terra-cotta, the character of the material selected must be given due consideration in determining the choice of a style.

It is hoped that the preceding pages are indicative of the fact that the government is not a mere machine, a soulless corporation, but, in each of its many departments, has at heart the accomplishment of the greatest good to the greatest number, and is, as in the days of Lincoln, a government of the people, for the people, and by the people.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

PRE-EMINENT SUCCESS OF THE DIFFERENTIAL PIECE-RATE SYSTEM.

FROM the point of view of the Socialist, the paternalist, and the trade unionist, every full-hand-worker in a given trade should receive a fixed and unvarying time-rate wage, regardless of his output; a man should rank as a man simply, and his pay should not be modified or scaled up or down in proportion to his real earning powers as evidenced by his output. The employer producing structures under commercial conditions of which profit and loss form inevitable features is perfectly aware that, of two men working side by side under seemingly similar conditions, one can and does earn vastly more than the other, and the employer finds that this superiority in production enhances the value of the speedy workman in an even greater degree than the actual ratio between his output and that of his slower mate, because of the greater area-production in which the quickness of the worker is the sole factor. Not only does the fast man do more work, but that work is done at a reduced fixed-charges cost, and the intelligent manager discovers that he must greatly increase the pay of the speedy man or decrease the pay of the slow man to make each equally profitable. Under these conditions the piece-rate at once suggests itself as a remedy. The piece-rate stimulates the slow artisan, and justly rewards the quick worker; tends to increase the area output, and lessen the fixed-charges drawback on profits; and fully justifies the extending application of this method of labor remuneration, which is now in evidence among the more extensive manufacturers.

Nothing is of more importance to the manufacturer who hopes that 1897 is to be the first of a series of profitable years than full information regarding such methods of labor management as have proved themselves advantageous through long use by prosperous and important concerns; and in this view it is believed that this paper, carefully prepared from the piece-rate methods of the Baldwin Locomotive Works, the Midvale Steel Company, and the widely-known establishment of Wm. Sellers & Co., will prove of immediate and timely interest.

A piece-rate may be fixed by guess, by experiment, or by analysis. If fixed by surmise, then the rate must in most cases subsequently be made greater or less, because mere guess-work rarely hits the mark. An early changing of the piece-rate is to be avoided, as indicating ignorance on the part of the management's agent, and only general change in the prices of the country can justify or excuse a change in a piece-rate which has been continued for a considerable period, except in case of manifestly improved means of construction. If the prices of all other commodities fall, as was the case in the United States from 1866 up to 1892–4, it is but reasonable that the price of labor should also diminish. If new methods or new machines are used which obviously lessen the labor before needed to make a piece, then the rate may justly be reduced. If the workmen increase their pay solely by greater skill and diligence, it is clearly unjust as well as short-sighted to deprive them of the result of their own exertions, and, except in the two cases of a general price-reduction throughout the country, or a lessening of labor through the use of improved means of production, piece-rates must not be changed, if the best results for both employers and workmen are sought. The master desires the most work from the fewest men, and the workman desires precisely the same thing, provided that he himself is one of the efficent few and can be paid in proportion to his real earnings. In a case where, by the action of an unchanging piece-rate, determined by the analytic method, twenty-two men finally came to turn out considerably more than forty-four day-workmen had produced, the efficient twenty-two were perfectly satisfied to be paid only a part of the gains directly due to their own superiority as craftsmen; had the shop made the piece-rate double the day-wage paid formerly to each of the twenty-two men, it would still have been the gainer in cost of plant, maintenance, and space; but very much less than a double day-rate was gladly accepted, and, in general terms, it may be said that a comparatively small advance above the highest current day-wage of his craft will hold the piece-worker.

The establishment of piece-rates by the experiment of making a certain number of the pieces by good day-workers is always most uncertain in its results, because the workman has every motive for making the experimental time great rather than small, and hence it is likely that the experimentally-established rate will be too great.

The analytic method of establishing piece-rates involves the reduction of the total labor to single operation elements, and the possession of an absolutely certain knowledge by the rate-fixer of the shortest time in which each of these operations can be performed. Say, in lathe work, the rate-fixer knows the least possible time in which a certain lathe can finish an inch length of a certain diameter of work twice over with one light roughing and one finishing cut. Knowing this, he can at once make an absolutely safe piece-rate for work of that class to be done on that lathe; or, if he knows how many pounds of metal a certain lathe can cut into chips in a day, he can then fix a rate for work which involves the removal of a large amount of stock.

The analytic determination is naturally followed by the utmost subdivision of labor, as in case of a common nut at the Sellers shops, where nut-tapping, nut-facing, and the finishing of nut sides are made each a separate step with a piece-rate of its own. This subdivision is the more desirable as it necessitates step-by-step inspection, and so immediately fixes the responsibility of bad work. With the unchanging piece-rate, so low that the good workman must make some exertion to reach the current day-pay of his craft, and yet so high that by diligence and wit he can very considerably exceed the best day-pay, excellent results may be obtained through natural selection of workmen; the eager and ambitious workers set the pace for the easy-going and contented souls, who either leave the work or increase their output to avoid constant reminders of their own inferiority. But, if workmen knew that piece-rates are to be reduced so soon as their winning rises notably above good day-pay, all incentive to exertion is removed, and nothing but a cut in the piece-price can increase the output of product. A cut made when men are drawing only good day-pay is always resented, and continued cutting of piece-rates leads to inevitable sulking and indifference to employers' interests,—conditions most unfavorable to the production of low-cost work. In the Sellers and Baldwin shops piece-rates once established are retained. In the Baldwin shops some rates have been unchanged for twenty years, and a man's value in that shop is estimated by the money he draws; the higher he makes his pay, the more valuable he is considered. In the Sellers and Baldwin shops and in the Midvale Steel Works foremen are paid day-rates, and have no way by which they can increase their pay. This does not give the foreman any incentive to extreme exertion, because his own interests are fully served if he keeps his place, and he gains nothing in money by doing more than his routine duties demand. To increase the foremen's interest in the business, they were, in one instance, made gain-sharers, the experiment beginning with a period of rising prices which gave a constant increase in the earnings of these foremen for several years, during which the management believed the gain-sharing plan a pronounced success. The end of the rising market came at last, with the result of a marked decrease in the total gains of the business, and of course a corresponding reduction in the pay of the foremen, who promptly waited in a body on the management, and, in the course of an amicable interview, expressed a unanimous opinion that they could do better than retain their positions. The management suggested careful consideration, and the foremen, after a time, presented a request for a return to fixed-rate payment, each man naming his own terms. All of these individual propositions were accepted by the management without discussion. Inside of a week after this acceptance, one of the foremen came to the management and asked an increase of the rate he had himself fixed for his own compensation, saying he had acted without sufficient reflection. The management refused the advance in pay, and all of the foremen remain to-day in their places at fixed rates. But labor troubles do not commonly include the foremen, and, while some device by which the most active interest of foremen in the business could be aroused and maintained is much to be desired, this is of far less importance than an effective stimulant to the efficiency of the workmen, who are the immediate factors in cheap production.

While the Sellers and Baldwin shops amply prove the value and entire practicability of the unchanging piece-rate system, it is quite possible that the "differential" piece-rate, devised by Mr. Fred. W. Taylor of the Midvale works in 1883, and put in operation in that establishment under the management of Mr. R. W. Davenport in 1883-4, is superior to any other form of piece-rate pay.

The principal obstacle to the initiation of a piece-rate system in shops accustomed to day-rates only is the supposed difficulty of fixing suitable rates on each of the vast multitude of greatly-differing pieces which together constitute the output of a metal-working establishment. That there is no real difficulty in this matter is proved by the fact that the Sellers shops, which produce a very large variety of machine tools as well as a great amount of specially-ordered work, and the Baldwin shops, building perhaps hundreds of different styles of locomotives, can and do make such rates for each member of their infinitely-varied productions.

The analytic method of rate-fixing is illustrated by Mr. Taylor in the following example of analysis of a planer job.

"*Work Done by Man.*	*Minutes.*
Time to lift work from floor to planer table..............	——
" " level and set work on table........................	——
" " put on stops and bolts....	——
" " remove " " "	——
" " " piece to floor..	——
" " clean machine..................................	——
Work Done by Machine.	
Time to rough cut ¼″ deep surface 4″ long 2½″ wide........	——
" " " " ⅛″ deep 3 ft. long 12″ wide.............	——
" " finish cut 4 ft. long 2½″ wide......	——
" " " " 3 ft. long 12″ "	——
Total....................................	——

Add —— per cent for unavoidable delays."

It is sufficient evidence of the possibility of accurate piece-rate-fixing by this method to say that it has been in use at the Midvale and Sellers works for many years. At the Midvale it has been in uninterrupted service since its first introduction in 1883-4, with entire satisfaction to all concerned.

The general effect of piece-rates at the Baldwin, Midvale, and Sellers establishments has been to double, and in some cases treble, the output of the plant, increase the yearly earnings of the men, and greatly reduce the piece-cost to the management. Fixed charges of interest, insurance, depreciation, superintendence, trade-soliciting, and so on are nearly constant, regardless of the volume of output; hence an increase in output greatly reduces piece-cost to the management. The following example is quoted from Mr. Taylor's paper:

"COST OF PRODUCTION PER LATHE PER DAY.

"*Ordinary system of piece-work.*		*Differential-rate system.*	
Man's wages	$2.50	Man's wages	$3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	$5.87	Total cost per day	$6.87
5 pieces produced.		10 pieces produced.	
Cost per piece	$1.17	Cost per piece	$0.69"

This example is given by Mr. Taylor in illustration of the value of his "differential" or two-price piece-rate system, but it also shows the effect of increased production in lowering piece-cost to the management, even when this increase is accompanied by greatly advanced workman's pay.

The peculiar feature of the Midvale system is the making of two rates for each piece, the low-rate being paid in case of long time used in production, and the high rate in case the production falls within a certain time-limit. For illustration, say, ten pieces of a certain sort have been decided upon by the rate-fixer as the maximum production per day, with a rate of thirty cents per piece, enabling the workman who reaches this probable maximum to earn thirty cents per hour. It is manifestly a loss to the management if the production falls below the maximum rate, and therefore a low price of twenty-seven cents per piece is made, to be paid in case the workman exceeds ten hours in the production of ten pieces. By this device of the "differential," or double-rate, piece-price, the skilful and diligent workman completing ten pieces inside of ten hours is paid $3.00 for his labor; if he completes them in nine hours, he still obtains $3.00, and has a gained hour at his disposal. On the other hand, the workman who uses ten and a half hours to finish the ten pieces receives only $2.70 for his work, and so makes up thirty cents of the time-loss in use of plant to the management, as is just, since this loss is due to the workman's own inefficiency. In point of fact, the time is rarely exceeded; in one case at the Midvale, out of thirty-six workmen on the same piece thirty-five were inside the time-limit, and obtained the thirty-cent rate, while one fell behind and exceeded the time-limit, and hence obtained only twenty-seven cents for each piece produced. Thus the double piece-rate offers an incentive for a maximum output which the single piece-rate does not contain, and its working effect is to ensure the largest possible production.

Under the simple piece-rate system used by the Midvale previous to the introduction of the double rate, there was one disagreement which resulted in the departure of 12 or 14 dissatisfied men. Under the double rate there has never been the slightest trouble, and it is almost needless to say that the Midvale men do not join trade societies founded on "equal rights and equal pay for all," because the immediate result would be a lowering of their own pay by their own choice, which is a conclusion most unlikely to be reached by the workman.

All the Midvale workmen, including those classed as laborers, are on differential piece-rates, and the effect has been to more than double the output with no increase of plant or material improvement in machines or methods. The laborer's low rate is 15 cents per hour, and his high rate is 18 cents per hour, earned at piece-rates. The machinist's low rate is 27 cents per hour, and his high rate 30 cents per hour, earned at piece-rates. There is also a boy rate, the minimum being 6 cents per hour.

There is evidence in several directions of the great working value of Mr. Taylor's double piece-rate system. First, under its workings the output of the same plant has been doubled, or more than doubled. Second, the men acquiesced in pay reductions in 1888-9, in 1890-1, and again in 1893, the 1893 rates holding unchanged until now.

The Midvale Steel Works now have about 1200 hands, and have been uniformly busy for several years. They were founded by William Butcher, who came here from England and established a small crucible steel work. In 1872 Mr. Butcher had retired from the superintendence which was temporarily in the hands of Mr. Wm. H. Durfee. A year later, with Wm. Sellers as president of the company, Samuel Middleton became superintendent, and the steel making was put into the hands of C. A. Brinley, with R. W. Davenport, now of the Bethlehem Iron and Steel Co., as chemist. Both were young men fresh from the Sheffield school. The following year Middleton died and Brinley became superintent, Davenport succeeding him as steel maker, and as superintendent in 1882. In 1872 and '73 the company was deeply in debt and had about 2000 tons of unsalable steel scrap in the yard. This was worked into rail blooms for the Reading railroad, and the manufacture of open-hearth steel was pushed, the Midvale having the honor of producing the first open-hearth steel tires, sending out three thousand, none of which failed in service, and thus obtaining a reputation for superior product in that line which is still maintained. The Midvale was also first to produce satisfactory steel railway axles in America; the Pennsylvania Railway sent trial orders to several establishments, and, the Midvale product proving best, constant orders followed. The Midvale was also first to furnish steel gun-forgings for the United States army and navy, and all of these manufactures—tires, axles, and gun-forgings, as well as steel projectiles—are largely and constantly produced. The establishment is enjoying an abundant prosperity consequent upon the high repute of its products.

Under the single piece-rate at the Midvale there was little increase of out-put. As an example of increase due apparently solely to the operation of the double rate, the production of steel tires has increased from 50 or 60 to 140 per day, with substantially the same plant and same methods.

But unquestionably the strongest evidence of the vitality and working strength of the double piece-rate is to be found in the fact that, although Mr. Taylor and Mr. Davenport have been away from the Midvale for a long time, the system continues in force, and is fully as successful in new hands as when under the fostering care of its introducers. It is often the case that details of labor management which give satisfactory results in original hands fail when others attempt to use them, and it seems conclusive proof of actual value when favorable results follow the continuance of an old policy under new management. In the light of these facts of largely-increased out-put without increase of plant, accompanied by perfect satisfaction on the part of the highly-paid workmen employed in producing this low-cost work, it is evident that the operation of the Taylor double piece-rate at the Midvale Steel Works demands the careful study of all superintendents who desire to be fully informed as to successful methods of dealing with labor.

The Midvale has a benefit system, based on a five-cent weekly deduction from the wages of each employee, which gives $5.00 a week during not more than twelve weeks of disability caused by accident in the works, and a 50-cent-per-capita assessment is made in case of death, which amounts to about $600, to which, after five years' service, $250 is added from the benefit fund.

The thanks of readers are due to Mr. William Sellers, Mr. C. A. Brinley, and Mr. Vauclain of the Baldwin Shops, for information courteously furnished for this paper. Personal mention of the Midvale officials who so kindly devoted time to the enlightenment of the writer was expressly forbidden, and is therefore regretfully omitted.

NICKEL STEEL IN METALLURGY, MECHANICS, AND ARMOR.

By Henry W. Raymond.

IT is a rather curious fact that the name given to the metal which, as an alloy with steel, has effected so complete a revolution in modern armor and bids fair to develop possibilities of which the metallurgist of a few years ago had no conception should have been given it originally in derision, owing to the impression that it was but a base ore of copper. Its use in coloring glass and in various alloys, as in German silver, is by no means of modern date, nor is its use as an alloy with iron or steel a new discovery. Piercy's "Metallurgy," published in 1864, devotes several pages to a discussion of the effect and value of its use, and says that Faraday and Stoddart had melted iron and nickel together in several proportions, and found them to alloy well.

It is said of an alloy of steel with nickel, made by Wolf of Schweinfurth, that "it had the aspect and properties of genuine Damascus steel," and that "nickel iron acquired likewise by the process a magnificent damask." Experiments made at the Washington navy yard some years ago with an alloy of nickel and iron produced remarkable results. The addition of one or two per cent. of nickel to cast iron both hardened, and increased the strength of, the metal to a quite unexpected degree.

The supply of nickel, however, was exceedingly limited, and the prices were correspondingly high, which made it too expensive for economical use as an alloy for commercial purposes. Scientists continued experimenting, and both in France and in England there were some who predicted a great future and almost unlimited possibilities for nickel steel.

Public attention, however, was not especially attracted in the direction of the experiments that were being made or the results obtained in this direction, until the publication of a paper read by Mr. James Riley, manager of the works of Tennant & Co., before the Iron and Steel Institute in England in May, 1889.

This may be regarded as the first authoritative statement, by a student and scientist of recognized ability, as to the possibilities of nickel when used as an alloy with steel. The paper also demonstrated that the author's experiments had been prosecuted for a considerable time, and were not yet completed; that what he had already accomplished was of so much importance that it had led to his employment by certain capitalists to continue the work, and had induced them to take tentative steps towards obtaining control of the nickel-supply of the world; and also—this incidentally—that Mr. Riley had been censured by those interested for having made public such conclusions as he had reached before the plan to create a nickel monopoly had been matured and carried into effect. Men do not create, or try to establish, monopolies for their own amusement. It is worth while, therefore, to glance very briefly at some of the principal facts in Mr. Riley's paper, and ascertain the estimate placed by him upon the results of his investigations.

In regard to the combination of the two metals, he notes that, if the charge is properly worked, nearly all the nickel will be found in the steel, almost none being lost in the slag; that the steel appears to be more thoroughly homogeneous; and that steel properly made will hammer or roll well, whether it contains little or much nickel. He also asserts that the hardness increases with the addition of nickel, until the nickel constitutes about twenty per cent. of the mass, after which further additions tend to make the steel softer and more ductile. The chief advantages in nickel are increased strength and ductility. Steels that are rich in nickel are practically non-corrodible, and those poor in nickel are much better in this respect than steels having none at all. As a possible explanation of the improved qualities possessed by steel when alloyed with this metal, Mr. Riley quotes M. Chernoff's view of steel,—that it is composed of crystals of metallic iron, cemented together by carbid of iron,—and accounts for the extra strength given to steel by nickel by its alloying with this carbid of iron to form a stronger cement. M. Chernoff maintains that the space between the crystals of iron is much more completely filled, and the cohesion between them rendered much more powerful, and that the points of solidification of the cement and crystals are nearer, producing or maintaining a more intimate interweaving of the elements.

This explanation is cited by Mr. Riley as a *possible* one, and not a conclusion which he would fully endorse. His own opinion of the value of the combination is thus forcibly expressed: "In wide range of properties and qualities possessed by these alloys, it really seems as if any conceivable demand could be met and satisfied." Mr. Riley also says that marine and civil engineers and ship-builders would be most interested in the alloys of five per cent. As to the military engineer he says: "There have not yet been placed at his disposal materials so well adapted to his purposes—whether of armament or armor—as those I have now brought under your notice,'' and he suggestively adds that, in his opinion, when the best method of treatment has been arrived at, ''their qualities for armor will be unsurpassed.''

In the discussion which followed the reading of this paper, Mr. Hall, of Jessop & Son, made the somewhat prophetic remark that it had been said that their society was a medium for sending out information to the whole world which their American cousins were the first to adopt.

Chief Constructor Hall of the navy wanted an opportunity to fire at a nickel plate corresponding to those already fired at.

Mr. Carbutt thought that, if armor plates could be cast to the shapes required, it would offer a great future to Mr. Riley.

Mr. Geneg said that the first experiments were made in Paris in 1882 or 1883. The nickel put to cast iron increased its strength, the breaking-strain, and its soundness. Plates six inches thick had been cast with increased resistance.

The president of the society ventured to predict that they would have nickel plates and nickel rivets placed *in situ* and welded up into a solid mass by electricity before the members then present were many years older.

Mr. Riley, in closing the discussion, said that one drawback was always urged against mild steel,—a want of rigidity, or elastic limit. He hoped this alloy improved it. He thought non-corrodibility another important feature.

It will be noticed that in Mr. Riley's paper, and also in the discussion that followed, the use of nickel steel for armor plates is only casually alluded to. Mr. Riley's researches had been directed toward ascertaining the importance and value of the alloy for general commercial use rather than for any special purpose.

The question as to the best armor for our armored ships early attracted the attention of Secretary Tracy, and to it he devoted considerable thought and study. With the failure of the Bethlehem Company to comply with its original contract, the problem of obtaining any armor at all demanded an immediate solution. The manufacture of the immense heavy plates was an entirely new industry in this country, requiring special tools and implements and the investment of a very large amount of capital. Battle-ships were to constitute our naval fighting force; those the secretary had asked for would require heavy armor and a large quantity of it; before making new contracts it was of prime importance to ascertain where and how rapidly we were to obtain it, and also to make sure that what we bought should be, if possible, superior to that in use by other naval powers. The very tardiness in delivery was perhaps a fortunate circumstance,—although at the time a constant source of worry and anxiety to the secretary,—since it gave time to experiment and to demonstrate which was the best armor plate.

England had not only covered her ships with one kind of armor,—and that the most vulnerable,—but had closed additional contracts for no less than ten million dollars' worth of the same kind. We were saved from premature adoption of armor that would have to be rejected or would be rendered useless by the very next advance step in investigation and invention.

This armor question the secretary regarded as of paramount importance. While seeking information from the manufacturers able to roll steel armor plates as to their possible output, amount of annual delivery, and rapidity of manufacture, he was also seeking information, wherever accessible, as to the experiments of nations and of individuals in this particular direction,—*viz.*, the discovery of a metal superior to steel in certain essential features.

In the early part of July, 1889, the attention of the secretary was called to the paper by Professor Riley. The experiments therein detailed appeared to him so remarkable in the line of developing a superior metal for armor plating, gun metal, construction plates, and projectiles that he considered it worthy of careful investigation as possibly of great value to our new naval force. He brought himself into communication at once with the owners of the mine in Canada which supplied more than four-fifths of all the nickel ore in the world. From them he ascertained that other nations were beginning to awaken to the possible importance of this new alloy for steel as a factor in future armament, and that one or two foreign governments had already offered to purchase the entire output of this Canadian mine at the owners' own price.

About this time the owner of the mine decided to go to Europe to see for himself to what purpose nickel ore was to be applied by those who were so anxious to purchase. A letter from the secretary to our naval attaché in London (Aug. 5, 1889), Lieut. Buckingham, introduced Mr. Ritchie to him as the owner of certain nickel mines, the product of which the department contemplated utilizing, and directed him to accompany Mr. Ritchie on his visit to English and continental manufactures, and to endeavor to ascertain the proportions, uses, and particularly the composition and treatment of the manufacture, of the alloy called nickel steel, and to report in full the results of this investigation.

August 20, 1889, Lieut. Buckingham reported that the English government was not using nickel in armor or guns, and that no company in England had yet begun to manufacture the metal for commercial purposes, although a syndicate was trying to get control of the patents and of the supply of nickel, and that The Nickel Company in France then controlled the nickel market. Nickel and iron bullets had been adopted by the French for their Lebel rifle, and were also in use in Austria and Switzerland, with a strong probability that they would soon be in use in Germany and England. Lieut. Buckingham's report was a valuable and interesting document. It recorded the important fact—among others—that nickel was being talked about abroad as an ingredient in an alloy to be used for armor plating, and that remarkable results were hinted at as having been obtained already in some minor trials.

Some months prior to this the secretary had decided to have a competitive test of armor plates of American manufacture. However, ample notice and repeated postponements did not secure any plates for the trial. In order, therefore, to properly test armor-piercing projectiles of domestic manufacture, a steel plate had been ordered of Schneider et Cie, at Le Creusot in France. During the absence of Lieut. Buckingham and his party in Europe, the representative of Schneider in this country informed the secretary that definite experiments had been made at their works with nickel-steel armor plating up to nine inches in thickness, and that suitable projectiles tried against it developed extremely valuable qualities in the new alloy. It occurred to the secretary that this would be a good time to make a comparative ballistic test of simple steel and nickel steel; so, on November 26, 1889, an order was placed with Schneider for "one flat and rectangular nickel-steel armor plate, 8 feet long by 6 feet wide and 10½ inches thick,"—the dimensions of the all-steel plate, and happening to be the dimensions of a plate recently tested in England. This brought about a comparison between two plates from the same firm, and also a comparison with results obtained under similar circumstances in England. The American representatives of Cammel & Co., learning of the proposed test, suggested that a compound armor plate be tried at the same time. As this would make the plate test thorough, a complete one was ordered, in accordance with this suggestion, to be ready at the same time as the others.

As the artillery power had been found insufficient at previous trials, it was directed that a velocity greater by one hundred feet should be given to the 6-inch projectile,—the caliber of the gun being the same as in the English trials; and, as former tests had been too restricted to be conclusive, an 8-inch gun was also made ready for use.

The facts as to the now historical armor tests at Annapolis are widely known. The wisdom of the secretary in making so thorough an examination into the important question of armor plating was thoroughly vindicated.

Summing up the results : the simple steel plate was penetrated, not perforated, through the entire thickness, the point of the projectile extending a slight degree into the backing, and three of the projectiles were thrown out to the rear of the plate. The character of the impact showed a relatively soft metal. Slight radial cracks extended from each of the impacts from one to two inches in length. The nickel-steel plate was penetrated to apparently the same depth ; two of the projectiles remained in the plate, and two were thrown out badly shattered. At the point of impact there were no cracks whatever, and the character of the metal indicated extreme toughness. The reactionary effort of the plate upon the projectiles was more severe in the case of the simple steel plate. The Cammel compound plate was perforated by each of the 6-inch shots, and cracked, and approximately one-sixth of the upper part was blown off, so that the plate was practically destroyed.

There being still some doubt as to the relative resisting capacity of the plates, the secretary ordered a further trial with the larger gun, the projectiles to have the same perforative energy, but the larger diameter tending naturally to produce cracking, which was an important feature to be tested at these trials. In this test the simple steel plate was cracked diagonally to the four corners, and was conclusively put out of the contest as an armor plate.

The Cammel plate was scattered, as some one facetiously observed, "all over the county."

The nickel-steel plate showed no cracks, and the penetration reached only to the rear face of the plate.

The simple was ahead of the compound, and the nickel equally ahead of the simple.

The department, not being committed to any armor, was thus free to adopt the best, which was proven superior to any then afloat.

It was but logical to infer that, in the face of these results,—which had been watched very closely by every naval power,—the attention of European nations would be directed at once toward this new alloy, and steps taken to make sure of a supply, should its extended use seem desirable.

The United States had been the first to demonstrate its superiority, and of necessity must be placed in a position to first reap the fruits of the discovery. With the exception of some unimportant mines in New Caledonia, the visible supply was restricted to the Canadian mines already referred to, owned entirely by American capitalists. The patriotism of its stockholders, which had so long held out against foreign offers, could not be expected to last indefinitely.

Whatever was to be done to prevent exclusion from participation in the triumphs we had ourselves obtained—*not* to create a monopoly—had to be done quickly. The secretary prepared a statement showing to congress that it was proposed to purchase enough of the nickel ore for the use of the United States in the development of naval material at present in progress, and to own it in the same manner as it possesses for use under similar conditions stores of niter to the extent of eight million pounds. It was not intended to purchase mines, or to go into the mining or smelting business, but only to make certain the obtaining of whatever quantity might ultimately be found necessary.

Further experiments were to be made, and, as the past twenty-five years had witnessed an enormous development in the older systems, a similar evolution might be anticipated in the case of the new alloy. Moreover, its value to the government could hardly be estimated, if the expectations of its friends were realized, and, if not, nickel ore always had a commercial value, and the purchase, therefore, of the right to obtain as much as might be called for could not entail any loss upon the government. In another direction besides that of ordnance it was believed that nickel plate might be of immense service. An experiment was said to have been tried with considerable success years before, as to the value of nickel as an alloy in the metal coating of ships,—to prevent fouling and erosion, two of the chief difficulties steel ships have to contend against.

It was under these conditions and for these reasons that the secretary asked of congress a grant of one million dollars to be expended at his discretion in the purchase of nickel ore or matte. Setting aside all partisanship, and uniting on the patriotic basis of the welfare and the need of the nation, and trusting implicitly in the honesty, integrity, and business capacity of the secretary, congress gave him what he asked for by a unanimous vote,—a proof of confidence of which he might well feel proud, and such as has never been given to any secreretary, unless, perhaps, in time of war.

All the nickel used in the armor of our ships has been purchased in the form of matte, and, after smelting, furnished to the manufacturers. American armor is all of nickel steel, and the English naval authorities were compelled to adopt it for their own ships as a result of our successful experiments. France has also begun its use, and, when face-hardened, it gives undoubtedly a greater resisting strength against modern projectiles than that afforded by any other form of armor plate.

As the many valuable qualities of nickel steel come to be more widely known, its use will become much more extensive, and it will receive new applications. Even now it is used largely for parts of machinery, such as shafting, connecting rods, piston rods, etc. If, as asserted, the metal can be cast, cut, drilled, and turned easily and well, it will have a wide application in machinery, especially for use in the parts which are usually kept bright. Its non-corrodibility adapts it admirably to such situations. Handles, levers, wheels, keys, and many minor parts can be made to great advantage from a material like this, which will not rust quickly from the moisture of the hand ; and heavier uses will be found in the working parts of large machinery exposed to unfavorable conditions of drip or atmospheric moisture. The Midvale Steel Works is making the shafting and engine forgings for the two battle-ships, "Kearsarge" and "Kentucky," of nickel steel, and many prominent firms use it for shafts. It is also used for small-arm barrels, and I believe that all the barrels for the United States navy small arms are made of nickel steel. Its use has been advocated for the plating of war-ships in this country, and in time this is pretty certain to be tried. In general, it may be said that it is coming into use for all purposes where a high elastic limit is desirable.

REVIEW OF THE ENGINEERING PRESS

The Largest Reservoir in the World.

THE Metropolitan water commission is about to build the largest storage reservoir in the world, its capacity being no less than 65,000,000,000 gallons, or, according to *Fire and Water* (Dec. 12), "enough to supply the city of Boston for three and one-half years, and four times as much as the capacity of all the existing water-works reservoirs of that city. Its capacity is twice as much as that of the new Croton reservoir of New York; thrice that of the six reservoirs of Birmingham, England; thirty times that of the Cochituate; and twenty-five times that of Hobbs Brook, of the Cambridge system. It will hold more water than the inner harbor of Boston." This dam is to be built at Clinton, Mass., and the vast volume of water, covering over four thousand acres, will be entrapped and retained by a dam 1,250 feet long (or 20 feet shorter than the Croton dam), 127 feet high above the ground, and 158 feet high above its rock foundation. This dam is, however, not as high as a number of others which retain much less water. The Croton dam has a height of 157 feet above ground and 225 above rock. "To guard against the pressure of the millions of tons of water that will be exerted on the dam, the engineers have made their plans with the greatest care, drawing upon every attainable source of information." The dam will cross a narrow gorge about three-fifths of a mile above the Lancaster Mills, at which point solid rock support for every part of the dam exists. It will be built wholly of masonry, having the same form of cross-section as that of the new Croton dam. Of the 1,250 feet length across the gorge only 750 feet have a depth exceeding 40 feet at high water, and only 270 feet have a depth exceeding 120 feet; "the maximum depth from high water to the rock at the down-stream edge of the dam is 158 feet." The overflow, 450 feet long at the northern end of the dam, is calculated to permit the escape of a rain-fall of eight inches over the entire area of water-shed supplying the reservoir. Some fear exists in Clinton regarding the safety of the town. Should the dam break away, the flood would certainly destroy the entire town of Clinton, and part of Oakland, Boylston, and West Boylston, and would submerge miles of territory on which stands some valuable property, and seven miles of the Boston and Maine railroad. The effect of building the dam is likely to be disastrous upon the town of Clinton in any event. "The Lancaster Mills, Clinton's chief industry, will be crippled,—perhaps removed,—in order that the Metropolitan district may not go dry." Churches, school-houses, and seven square miles of taxable property will be taken, and, altogether, the inhabitants and owners of the property have some cause for worriment. An expensive change in the system of sewerage in Clinton will also be compelled. The uneasiness of the inhabitants has been heightened by a proposed petition to the legislature for permission to increase the height of the retaining wall of the dam by seven feet, which, if it be done, will increase the holding capacity of the dam to 100,000,000,000 gallons.

The Business Wisdom and Responsibility of the Engineer.

THE proceedings of the Purdue Society of Civil Engineering for 1896 contain an address upon this subject, delivered by Mr. W. F. Goodhue, an engineer of ripe experience. The address is free from technicality, and deals with the relations of civil engineering to the great public enterprises of the present time, the emoluments of the profession, and its standing as compared with that of other professions. In particular,—as indicated by the title,—the responsibilities of engineers, and their deficiencies in business training, are made the prominent topics, the lack in business training being assigned as one of the reasons why compensation is less in this than in other professions involving no greater responsibility. The legal profession is cited as one wherein the rewards for equal acquirements and service very much exceed those received by civil engineers. An interesting case is narrated in detail, wherein a lawyer appointed as a receiver for a western railroad ran it for five years and nearly "ran it into the ground, receiving for his services, by order of court, the sum of $125,000. An engineer employed to practically rebuild the road after all this mismanagement labored six long years at the task, put the road into first-class condition, and received as his pay about $12,000. This was a personal experience of Mr. Goodhue; in citing it, he disclaims any intent to disparage the legal profession, his purpose being to illustrate the generally-recognized value of a lawyer's services, and "the tenacious grasp which a lawyer holds upon all properties which he is called upon to control and manage," which is in striking contrast with the weakness of hold of the engineer, who, working harder than the lawyer, receives only a fair compensation, "and seems to be at all times outside, and never a part, of the business management . . . of the concern he serves so well and faithfully." Reasons for this are found in the fact that engineers narrow themselves down too much to details, instead of leaving these to subordinates; in the fact that they are deficient in knowledge of human nature, and in the tact needed to manage men; and in the fact that they lack business training, and are, as a rule, much too modest for their own good. "So many engineers in charge of work want to see and do everything themselves. They have a great horror of errors and mistakes, and are willing to trust nobody. Their heads are full of measurements, weights, elevations, designs, and all the ins and outs of the work in hand. They are a sort of monomaniacs on the rules of construction, and, for the time being, live and exist upon their work, and have no thought or care for anything else. Timid themselves, they teach timidity to their assistants. . . . They are seldom in the cabinet and always in the field. The lawyer is always in the cabinet and seldom in the field." These habits stand in the engineer's way of acquiring influence and charge of large business interests, which the lawyer so easily gains, and so firmly retains. But not these alone handicap the engineer in the race for worldly prosperity. "The engineer of to-day should be a practical business man, and it is well if he acquire his business training, partially at least, by actual contact with business methods. He should be as well versed in business as are the lawyer, the contractor, and the maker and dealer in materials, as he is brought daily into contact with one or more of these persons." The engineer should also know something of law. A thorough law course would benefit any engineer, but this is not urged as necessary. It is desirable, however, that "the engineer should know enough of business and of business laws to prevent the subordination of himself in his own chosen field of labor." As an example of a thorough-going business man and successful engineer, Mr. Goodhue names the late General Adna Anderson, and gives a very interesting sketch of his character and life-work, based upon personal experience as one of his assistants for a term of eight years. This great engineer, whose achievements form an honorable record in the military and civil history of the United States, "built more miles of railway than any other man in the United States, if not in the whole world." Of him Mr. Goodhue says: "He paid less attention to the routine and minor details of work than any engineer I ever knew." Of him General Sherman said: "He was a man who talked little and met all your expectations." A saying of General Anderson's that "a man without responsibility should be held as an outcast" introduces the topic of responsibility. The wholesome caution not to accept a responsibility unless the right of self-protection goes with it is formulated, and illustrated by an instance of historical interest,—the failure in 1876 of the bridge near Ashtabula, on the Lake Shore & Michigan Southern Railway, and the subsequent suicide of the chief engineer of the road, who neither designed or erected the bridge, or had anything to do with its acceptance, but who, notwithstanding, allowed it to stand eleven years without protest, or until the combined strain of a burden of snow and the passing of a passenger train finally broke it down and caused the death of seventy-two persons. Here was an assumption of responsibility without the power of self-protection. The circumstances were such that a protest from this engineer would doubtless have caused his discharge. For this reason, or some other, he did not protest, thus placing himself in a position of great hazard, the consequences of which he escaped by a self-inflicted pistol-shot on the night of the day in which the responsibility was fixed upon him by the testimony of the designer of the bridge at the subsequent inquest.

Coal Washing.

It is not understood by the general public that the fitting of coal for market at mines is now extensively done by a process called "coal washing." Like many other technical terms in use, "coal-washing" will hardly convey to the lay reader an accurate idea of the thing it stands for. Under it are included different modes of procedure, though all have for their object the separation of coal into special sizes, as well as its separation from slate, bone coal, pyrites, and, sometimes, other and less important impurities. In a paper read before the late meeting of the American Society of Mechanical Engineers, Mr. J. N. Schaefer discusses the subject of coal washing, emphasizing its growing importance, and more particularly describing the Luhrig process as applied to bituminous coal. The extent to which substances (principally slate) which go to form ash and pyrites may be removed by washing is exhibited in a table by Mr. Schaefer. An average computed from this table shows that unwashed coal from twenty-nine different localities gives a mean of 11.01 per cent. of ash. The same coals washed give an average of 3.866 per cent. of ash, or a little more than one-third. The table also shows that some coals are much more improved by washing than others. Thus a coal obtained from Comox, Union Bay, B. C., had its 35.5 per cent. of ash, as it was mined, reduced to 8.5 per cent. by washing. The paper under consideration was printed in the transactions of the society at which it was presented, and has been reprinted in *The Engineering News* (Dec. 17). It is explained that a thorough system of washing bituminous coal comprises the careful separation of the coal into different sizes,—No. 1 and No. 2 nut, No. 3 and No. 4 pea, and sludge. The latter is the fine coal which settles out of the water that has been used for washing. After this sludge has been removed, the water may be used again for washing, and so on indefinitely; about a ton of water suffices for washing a ton of coal. In all coal washing the separation of the principal substances to be removed is based upon the fact that they have a greater specific gravity than that of coal. This principle has long been used in concentrating ores. When the coal and its impurities are shaken up in water, the heavier impurities more or less quickly find their way to the bottom, while the lighter coal forms a top stratum. When applied to ores, this process is called "jigging." The best results have been attained by the use of the old Hartz ore jig. "This jig consists in general of a box, divided vertically into two compartments, from the top to a point below the water line. In one of these compartments, a plunger plays up and down. The other compartment is closed near its bottom by a screen. Coal is placed continuously on the screen near the partition, and water is forced into the back of the other compartment below the plunger. The action of the plunger imparts a pulsating motion to the water, which, acting upward through the meshes of the screen, lifts the lighter parts, allowing the coal to flow out of the front of this compartment near the top, while the slates pass out at a point lower down." In the Luhrig system pieces of broken feldspar are placed upon the screen when fine coal is to be treated, which renders more tortuous the passage out of the refuse, and enables the lighter particles of coal to be more thoroughly separated. This is by no means so simple as it at first appears. "It must be kept in mind . . . that success in coal washing does not depend so much on individual machines and appliances, which can be made in any good machine shop, as it does on the process and the system upon which the whole plant has been built and is operated. The nature of the coal, and the purposes for which it is to be used, must, in every case, be taken into account, and the plant designed accordingly. It follows that every plant is different from others, and imitation of previously-carried-out plans is generally faulty and disappointing. It is, therefore, advisable to place the design of washing plants in the hands of an expert who, by training and experience in this particular line of work, is qualified to so systematize and arrange the plant as to meet existing conditions and produce the best results." An interesting description of a Luhrig plant as designed for a six-hundred-ton daily out-put, and now being built at the Alexandria Coal Company's Crabtree mine, at Greensburg, Pa., is comprised in the paper, facts being given that will be new to many readers, as well as important to those interested in the American coal industry.

How American Electric and Cable Traction Would Meet British Requirements.

THE RAILWAY WORLD for December publishes a communication upon American cable and electric traction, specially considering how far these systems, as carried out in this country, would be adapted to British requirements. The views expressed seem to have been gathered from the personal observations of an intelligent Englishman, who has made the matter a special study during a visit to the United States, and who has devoted much attention to the financial aspect of present methods, and the pecuniary result of recent improvements. He first notes that cable-traction is not making much progress in America, and says that "some of the reasons for this fact are not applicable at all in Great Britain," while the others "are only applicable in a very limited degree." The inference is that, unless other reasons, of equal force, why the cable traction should not progress are found in England, the system should stand a much better chance there against the competition of electric haulage than in the United States. Our own opinion is that no more important cable roads will be built in the United States, except under conditions that practically preclude the employment of other modes of haulage, or where very heavy grades have to be encountered. According to the correspondent of the *Railway World*, there are, however, those who will not concur in this view. He says: "In quite a number of cities I found men who are either officers of electric street railways or are connected with manufacturing companies declaring that cable traction is antiquated, and that it must give way to the trolley wire. On the other hand, men connected with some cable roads, and experts who are independent of any company or system, maintained that now, as in the past, no means of propelling cars is so economical as cables where grades are severe or where traffic is heavy." As a matter of fact bearing upon this point, cable traction on roads in no less than nine important cities in the United States has been set aside, and the trolley system substituted. The conditions in England which favor cable-traction, as compared with the trolley system, may be understood from the statements that cable speeds in America on the great thoroughfares are often as low as in England, while wages are very much higher; that British cable lines with only a fair traffic are capable of earning very large profits; and that a cheaper style of cable construction prevails in England. A contemporaneous development of both cable and electric roads is, therefore, considered more probable in England than in the United States. The system of uniform fare in vogue in the United States, where a passenger may ride one-half mile, ten miles, or sometimes even more, for a five-cent piece would, it is thought, be opposed in England. "A one-penny fare would not pay, and two-pence would be fiercely resisted by all short-distance riders." It is, notwithstanding, very strongly approved by this English observer. In view of the fact that the suburban trolley roads are solving the problem of over-crowding in American cities, "it remains a fact that high speed and a uniform fare would probably do more for the workingman in England than all the municipal improvement schemes." This suburban passenger traffic is regarded as the beginning of a social revolution, the influence of which will rapidly widen during the next few years.

Gas Producers.

In a paper read last October before the Civil Engineers' Club, Cleveland, Ohio, and published in the *Journal of the Association of Engineering Societies* for November, Mr. C. L. Saunders claims that "producer-gas is the cheapest artificial fuel gas per unit of heat," and asserts that it "is rapidly gaining recognition among engineers as one of the foremost means of effecting a saving in cost and an improvement in the quality of manufactured articles." He also notes its increased and increasing use in general industry, and classifies as follows the principal processes for manufacturing it which have recently come into extended use:

"(1) Gas processes which are essentially water-gas processes. In these the air and steam are admitted at the top and drawn down through an incandescent bed of fuel by an exhauster.

"(2) Fuel-gas processes, which are combined water- and oil-gas methods, effecting the decomposition of hydrocarbons injected in small quantities at a number of points.

"(3) Gas producers, with water-troughs for bottoms to permit the continuous removal of ashes, either by manual labor or by a screw conveyor.

"(4) Gas producers having revolving bottoms to facilitate the removal of the ash and clinkers, which are discharged continuously over the edge of the revolving bottom into a sealed ash pit beneath, without interfering with the making of gas."

Those who desire to engage in the manufacture of producer-gas, after selecting the process from one or other of the classes enumerated, will next have to consider how to convey the gas to the point of consumption, and the general construction of the apparatus in all its details of flues, cleaning doors, manholes, burn-outs, valves, etc. The author urges that these are not unimportant, because minor, details, and declares that upon judicious attention to them the success of the undertaking will in large measure depend. "Very often," he says, "a superintendent finds that his men have failed him, and that he must depend on green and ignorant hands,"—a contingency that should not be lost sight of in designing the plant. This is as much as to say that a producer-gas plant must be such that, with proper direction, it may be run with help quite unused to the industry. Another element of success is the knowledge of not merely what the coal intended to be used will do in the laboratory, but what may be expected of it in the every-day, regular industry of making the gas with the aid of "cheap and ignorant men unaccustomed to working gas-producers." Particulars of the kind of coal suitable for the industry are given. The paper itself must be consulted for these, but we may quote the general statement that "it should be a coking bituminous coal of good quality, rich in . . . volatile hydrocarbons and with a low percentage of ash." Another essential to highest success is a proper plant for handling coal and ashes.

There follows a classification of coal-handling plants, which contains useful hints to any who may be interested in the progress of the industry financially or otherwise.

A New Departure in Electric Elevators.

A very promising invention, made by Mr. H. Russell Smith, of Chicago, is illustrated and described in *Western Electrician* (Dec. 10). The final outcome of this invention, should further experiment verify its practicability, will be a great simplification, and reduction in the number, of the working parts of elevators, particularly those used in tall buildings for passenger service. The inventor has boldly adopted the old principle of the solenoid and core, meeting the difficulties in a very ingenious manner. If we suppose a solenoid to replace a hydraulic cylinder, and a core to replace the plunger in such a cylinder,—this core being connected with the car by a system of multiplying sheaves in the same way as the plunger of a hydraulic elevator is now connected with the car,—we may thereby comprehend the general idea of this invention. In order to obtain sufficient amplitude of motion in the core, and uniformity of pull, the solenoid is made up of a series of coils supported on a central brass tube in which the core moves, these coils being so connected with a commutator that any number of them may be excited in series, and each successively cut out of the circuit while another is connected in. In this way coils, say, *a*, *b*, *c*, and *d* can be used, and, when *a* ceases to act, a fifth coil, *e*, begins to act upon the core, and so on. The current is reversed, for reverse motion of the core and the connected car, by a second set of brushes under control of the operator. The only working parts which have rotary motion are the sheaves. No dynamos or pumps are required. The necessary current may be taken directly from central-station wires. The details for regulating motion, over-balancing, stopping and starting, and the safety appliances have been worked out in an ingenious way at a large elevator works in Chicago, wherein the apparatus has been made the subject of experiment for a considerable time. As, however, no data of trials are given with the description, it is safe to reserve judgment until these are supplied. The advantages of such an arrangement, if it can be perfected, are obvious, and the difficulties do not seem greater than those which have been successfully overcome in some other electrical engineering work. The progress so far attained justifies, we believe, the view that this new departure has much promise.

The Congressional Library.

A RECENT article which incidentally mentions the subject of roofing, is an illustrated partial description of the new Congressional Library at Washington, D. C. (*Scientific American*, Nov. 14). The roof of this building is of sheet copper, the dome being gilded with pure gold leaf,—a more durable covering than paint, and one which will not need frequent renewal. The style of the building is that of the Italian renaissance. Its reading-room will probably rank among the finest in the world. It is nearly circular in plan, 100 feet in diameter, and 125 feet high, and is surmounted by a noble dome supported by columns of Tennessee, Numidian, and Sienna marbles.

The scaffolds used for decorating the interior of the dome constitute the main theme of the *Scientific American* article. The decoration consists of stucco work in *alto relievo*, and paintings by Edwin H. Blashfield.

The scaffolds used in constructing the dome and in applying this decoration were rotative, guided above by a pintle at the apex of the dome, and resting below upon wheels that worked upon a circular railway extending around the base of the dome. The structure carried by these wheels was a pair of trusses crossing or intersecting at the center, and carrying five separate floor spaces six feet apart, the flooring being supported by horizontal angle-irons which served as floor-beams. By this ingenious device all parts of the interior of the dome were rendered conveniently and safely accessible to the workmen and artists. This well illustrates the fact that modern architecture, as time advances, more and more combines the skill of the engineer with the art of the designer.

The building, with its grounds, occupies an entire square, admitting of artistic architectural treatment on each of the four sides. It is 470 feet by 340 feet in plan, three stories in height, with four interior courts, and is lighted by 2,000 windows.

Other interesting particulars are presented in the article mentioned, the illustrations in which will give a good idea of the construction and operation of the rotative scaffold,—one of the most interesting engineering features in the construction of the building.

Apprenticeship in Machine Construction.

WITHIN a year or so, if our memory is not at fault, complaint was made through the correspondence columns of the *American Machinist* that there is an increasing dearth of skilled mechanics. With reference to this statement, the editor of that paper remarked, in substance, that, if certain shops had been troubled to get such help, it served them right, since they refused to take apprentices, and thus contributed to the very disability of which they complained. The subject seemed of sufficient importance to justify an investigation, which was accordingly instituted by our enterprising contemporary, and in its issue of December 24 the results are presented in tables and in letters from a great many prominent machinery-building establishments and railway systems of the United States. These statements seem to indicate that, if skilled, all-around mechanics are really becoming scarcer relatively to the demand for such workmen, some cause besides the decadence of the apprenticeship system must be sought; for, contrary to a wide-spread belief, these data show that, out of one hundred and sixteen engine builders, machine-tool builders, railroad and locomotive shops, and builders of miscellaneous machinery that have replied to inquiries, nearly seventy-five per cent. yet adhere more or less to the apprenticeship system, and, for the most part, approve it, and find its operation satisfactory. Many also affirm it to be the duty of every machinery builder to take apprentices, and, if this be the fact, the practice, like the performance of all duty, must redound ultimately to the good of the trade.

These letters are from representative establishments, which, of course, adds very much to their value. Though not made a subject of special inquiry, the subject of trade schools, as a substitute for apprenticeship, was alluded to in the circular letter, and an expression of opinion upon this point is given in a number of the replies. Most of those who say anything about them appear to regard the trade schools as a very inadequate substitute, although conceding their general usefulness.

In connection with these replies are printed communications from officers of two trade unions. A letter from Mr. James O'Connell, grand master machinist of the International Association of Machinists, says that one of the planks in the platform of the association is as follows: "To endeavor to secure the establishment of a legal apprenticeship of four years." The reasons for this endeavor are given, and are followed by a defence of trade unions against the charge of arbitrariness in the limitation of the number of apprentices that shall be taught a trade within a certain period of time, this defence containing only the familiar reasons hitherto assigned for such action. A letter from Mr. Martin Fox, chief officer of the Iron Molders' Union, also defends the restriction of supply, and, by implication, approves the system of apprenticeship only when so restricted. Aside from the effect of this restriction upon wages, he alleges that it will make better, because more thoroughly trained, workmen, and he notes an alleged glaring defect in the old apprenticeship system,—to wit, that, under it, apprentices are not properly instructed, but are set adrift upon the world as botch mechanics. We think our contemporary has not overrated the interest that the industrial world will take in this investigation and discussion. It is high time that the future supply of skilled help in the machinery trade and in allied trades should be seriously considered, particularly if the trade-schools are not meeting expectations. We are sorry that this latter point was not made one of the subjects of special inquiry. The public would be glad to know approximately how far these institutions are fulfilling their mission.

Turret Deck Steamers.

THE past few years have been prolific of new types of ships, among which the whaleback is one of the most notable. Since the advent of the whaleback, the so-called turret-deck steamers, the first of which was built at the yard of Thomas Doxford & Sons, at Sunderland, England, in 1893, seem to have served a useful purpose, since the firm named has built thirty-one of them, averaging a tonnage of 4,300 and is now building one of 6,000 tons. *The Scientific American Supplement* (Dec. 12), in describing this type of vessel, adds that two still larger vessels of this kind, each four hundred feet long, are also being built in the same yard. The description is aided by illustrations, but a general idea of the peculiar features of a turret-deck steamer may be formed from the following outline. The side-plating of this type of vessel is "rounded over with an easy curve, as in the whalebacks, but, instead of being carried clear across to form a deck, it is rounded upward again with a return curve to the level of the upper deck, which is comparatively narrow, and extends flush, and without any shear, throughout the whole length of the ship. A cross-section of the upper part of the ship would present the appearance of a pair of rounded Z-bars, all the advantages of structural stiffness which are claimed for Z-bar shapes being gained by this arrangement." It is claimed that this renders it possible to dispense with much of the interior stiffening required in iron ships of pre-existing models. The aim has been to attain a sort of cross between the whaleback model and that of an ordinary cargo steamer, the whaleback having been designed with a view to reducing dead weight relatively to capacity for cargo. The turret steamer is intended to give "a maximum carrying capacity on a minimum net register combined with light draught." The first one built carried 3,200 tons on a net register of 1,262 tons, and drew eighteen feet of water "The turret decker is provided with a short forecastle deck, and, as the turret-ways do not extend to the bow, these ships have a high free-board forward, and should make good weather when traveling head to sea." The use of joggled plating, now widely adopted in English and continental ship-building, is said to have been introduced by the firm which is building these turret deckers, now built with plates lap-jointed and joggled. The appearance of a turret-deck steamer contrasts poorly with that of the ordinary steamship, but vessels of this type are claimed to be very seaworthy, and—what is much more important in this commercial age—they have proved profitable to owners.

Electrical Distribution.

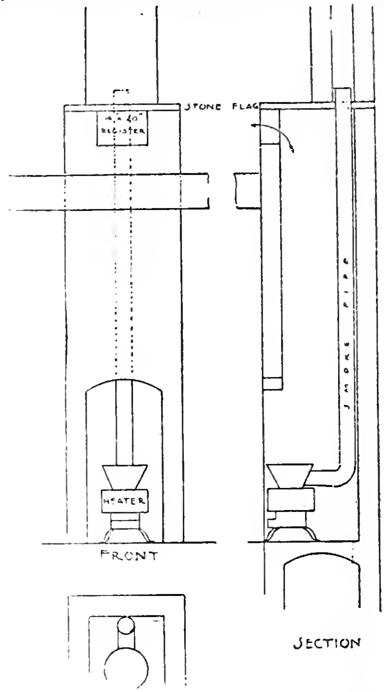
THE principles of electrical transmission, applying equally to electric lighting, power, telegraphy, telephony, and the technical and scientific problems involved therein, form the subject of a series of articles by Mr. Francis B. Crocker, beginning in *The Electrical World* of December 19. To those familiar with current electrical literature, the name of this writer will sufficiently guarantee the value of the series; it will be well, however, to outline briefly the method of treatment. The fact that methods of distribution have been furthest advanced in connection with electric lighting—this application requiring a more perfect regulation of pressure and current than the other applications named, and also possessing "the advantage of employing practically all the known methods of electrical distribution," —leads the author to recommend further study of this phase of the subject.

In the first number of the series are treated the measurement of conductors, materials for electrical conductors, electrical resistance, and the standard conductivity of copper. The need of further study becomes apparent from the fact that not only in long-distance transmission, but also "in an isolated electric-lighting plant, the wiring is more expensive than the engines and dynamos combined, even where the maximum distance of the lamps from the generators is only a few hundred feet." This is regarded as surprising; to most of the uninitiated it will be almost startling. American readers will perhaps be gratified that, in discussing the measurement of length of conductors, the foot is made the unit, and that for thickness of wire the American wire-gage (Brown & Sharpe) is the chosen standard. The word "*mil*" (plural, "*mils*") is employed to mean one one-thousandth of an inch, and a "*circular mil*" is the area of the cross-section of a wire one mil in diameter. The area, in circular mils, of any circular cross-section is the square of its diameter in mils. Thus the area of cross-section of a wire of four mils diameter is sixteen circular mils; for a wire of ten mils diameter, one-hundred circular mils, etc. A comparison of copper with other available conducting materials shows that aluminum is, for a given weight, much superior to copper. A pound of copper wire has for its equivalent 0.56 of a pound of aluminum wire of equal length and resistance. But aluminum wire has the disadvantage that more insulating material is required to cover it, its cross-section being nearly twice the area of that of an equivalent copper wire. In the discussion of resistance,—characterized as "the most important factor in distribution," both from scientific and commercial points of view,—we are confronted with the fact that the cost of copper is the largest item of expense in almost all electrical plants. Whether, or not, this will always so remain it is impossible to say. To reduce this factor of cost, either copper must be more cheaply produced, or some substitute for it must be found. So far, we have no knowledge of any alloys that reduce resistance below, or even down to, the sum of the resistances of their constituent metals when used separately in wires of equal combined weight and length.

Heating and Ventilating Stables.

In the course of a series of articles on stables, begun in *The American Architect and Builder* (Oct. 10), the author, Mr. C. H. Blackall, describes and illustrates a method of heating a stable of moderate size. Mr. Blackall's style, and the practical character of the series, are exemplified in the treatment of this topic, the cuts of the heating apparatus herewith reproduced.

Premising that the harness-room will be entered directly from out-of-doors (considered the best arrangement, as excluding ammonia and other gases from this room), that its walls and ceiling are sheathed throughout, and that the room is well lighted, having a single drop-light in the center for artificial lighting, the author claims that the heater for the entire stable can best be located in this room. The heater, Mr. Blackall says, has been found very satisfactory in practice.



"The stove, or heater, is set in a recess thirty inches square, formed by eight-inch brick walls on the sides and back, and open in front, the hearth also being of brick though this need not be carried out beyond the line of the brick walls. At a height of five feet above the floor, the front of the recess is closed-in by an arch and the eight-inch brick wall carried up on all four sides to a height of about two feet above the loft floor, where the space is topped off by a horizontal stone flag with a hole cut in the center. Just below this, in one side of the brickwork, can be set a register. The smoke-pipe from the heater is carried up inside of the brickwork and through the stone flag above to second floor, where it terminates, the brickwork above this point being narrowed down to the dimensions of an ordinary flue and carried out through the roof. The radiation from the heater is amply sufficient to heat the harness-room, and enough surplus heat goes up in the brick recess and from the smoke-pipe to supply heat for the man's room in the loft."

THE BRITISH PRESS

A New Departure in Sewage-Treatment.

THE place where this departure has been taken is Sutton, England, and the account of it from which the following description has been prepared appeared in the the *Sanitary Record* (Dec. 11). The experiment was made under advice of Mr. W. J. Dibdin, chemist to the London county council, and by consent of the Sutton urban council. Mr. Dibdin, having come across the minute organism, *Micrococcus candicans*, while analyzing the affluent from a coke-breeze filter-bed,—this organism being known to fatten and thrive on the matter in sewage which, from a sanitary point of view, it is desirable to eliminate,—the idea occurred to him of preparing a bed with these *candicans*, charging it to repletion with sewage, letting the bacteria gorge upon it to repletion, or until they had exhausted the supply, and then examining the resultant affluent. After a mature consideration of this idea, he proposed it to the Sutton urban council as a possible mode of solving the problem of the sewage disposal of large towns, and obtained the privilege of experimenting in one of the settling-tanks, which was set apart for the purpose. A complete system of under-drainage was first laid down, on which was placed a bed of burnt ballast four feet thick, and then water from a filter-bed which contained the micrococcus was pumped upon the bed. The bed was now ready for the reception of the sewage, and was accordingly charged with 25,000 gallons, the full quantity it is designed to hold. No chemicals or lime were used. The sewage was turned in exactly as it came from the sewers, and there left for a couple of hours for the bacteria to do their work. The *Sanitary Record* obtained its information from an article in the *Sutton Advertiser*. Our experience with statements of experimental results as given in American daily papers warns us not to repose too much confidence in their statements of scientific facts, especially such as experts only are competent to judge. We give, however, the results as stated by the paper named the more readily as the *Sanitary Record* appears to give credence to them. The *Advertiser* says that, so far as could be judged from the results, the experiment was entirely successful. The effluent, though not pure enough to be potable, is said to have been certainly much clearer and much better looking than that which comes from the settling-tanks; and it is added that this effluent might, at a pinch, be turned into the stream without any fear of the Thames conservancy inspectors raising any serious objections. It is not intended, however, that this shall be done, the present proposal being that it shall pass through the filters, or over the land, as is done with the other effluent, so that a clear, pellucid stream may flow into the Pylbrook. The process differs from the old plan of passing sewage through burnt ballast, coke-breeze, etc., in order to remove the solids, in that the bed is charged with bacteria before the sewage is turned in, and, instead of there being one continuous stream of foul matter, the charge is allowed to rest awhile after it has flowed in. The process appears to be analogous to the fermentation of the wort in brewing, wherein the action of a rapidly-multiplying organism, contained in the yeast culture, changes the character of the entire mass in a few hours. At present two hours are allowed for the bacteria to do the desired work, and a period of aeration of the same length is then allowed, in order to prevent the bed from becoming choked. The time needed for charging and discharging, in addition to the above, makes it possible to deal with only two charges, or fifty thousand gallons per day, in this one bed. Should permanent success crown this effort,—which, in view of the many failures of processes for sewage-treatment that have preceded it, is yet problematical,—it is said that the council of Sutton will convert all settling-tanks of that town into bacteria beds, and treat all their sewage-flow in like manner. If successful, the necessity for costly settling-tanks and costly pumping and pressing machinery would be obviated, and it is estimated that bacteria beds for a large town could be constructed for less cost than that of the machinery required at present, while the working expenses would be reduced to a comparatively nominal sum. Of Mr. Dibdin as an expert in sewage-treatment it is said that he "is responsible for the treatment of more sewage than any other man alive," and that his reputation is too high to be hazarded by any practical experiments of the success of which he entertains any doubt whatever.

The Motor Car in 1896.

FOR various reasons we have not said much about motor carriages in these reviews. Regarding this kind of vehicle as in a very early stage of imperfect development, and there being very little to say of results, except by way of recording shortcomings and failures to meet the obvious requirements, we have thought it wiser to use space for more important features of the later nineteenth-century progress. It appears to us that in the Serpollet system the nearest approach to a practical motor carriage has been made, but certainly this is yet very far from being a vehicle adapted to general use as a substitute for wagons drawn by horses. We note that the clumsy and awkward term "horseless carriage" appears to be disappearing from current technical literature. In England, where much effort has been expended to obtain a practical locomotive road vehicle, the term "motor car" is coming into use, and is sufficiently short, convenient, and acceptable. Under the title, "The Motor Car in England in 1896," *The Engineer* (Dec. 4) sets forth the characteristics of the English motor car at the present date. The title indicates a belief that the different makes are so nearly alike in principle as to permit them to be considered as one and the same genus, and the subject is discussed in harmony with this assumption. The position is taken that, had there been no light oil-engine, there probably would have been no motor car at all worth naming. "Petroleum spirit" (as the lighter product of petroleum distillation is called in England) is the agent which, through the labors of many able men (Dugald Clark in particular), has been applied to engines adapted to motor-car propulsion, and has supplanted nearly every other hitherto-tried means for the purpose. Our contemporary truly says: "At the present moment the spirit-propelled motor car is first, and the rest nowhere." But it is predicted that the motor car of 1896 will soon pass into history, as one of the abortions of inventive genius, in an age of mechanical triumphs. What is the motor car of 1896 as it exists in England? "The modern motor car is a vehicle the hind wheels of which are caused to turn round by a petroleum engine. If we come to examine any of these vehicles, we shall find that they are, one and all, constructed on the same general lines as though they were to be drawn by horses. The result is that they are ungainly in appearance. They offend the eye by what they obviously lack. Not a few of the Victorias and four-wheeled dog-carts which are pronounced ugly would look very well indeed if drawn by a good pair of horses. The makers have evidently taken a Victoria, let us say, removed the pole, and fitted a horizontal oil-engine under the body. The two are, as a rule, a very ill-assorted couple. Neither seems to be quite suited to the other. There is not yet in the market—at all events, it has not been seen in England—a thoroughly-well-thought-out-and-designed motor car in which the features of the engine are properly subordinated and harmonized with those of the vehicle. We have heard that in France some vehicles much better than anything yet seen here are being made, and we see no reason to doubt it. The thing is very far from being impossible of accomplishment." The dangers attending a general use of petroleum spirit as an agent for propelling road vehicles are not insignificant. Such a product is more dangerous in storing and handling than gunpowder, forming, as its vapor does by mingling with air in proper proportions, a violently explosive mixture. For this reason alone the general sale and use of petroleum spirit as an illuminant in households have been prohibited by law. Here, then, is one reason for a belief that the motor car of 1896 will soon become a matter of history. Another reason is the fact that oil, gas, or spirit engines cannot be stopped and started like a steam engine, by merely opening a throttle. They must be assisted by hand in starting, and, as this is practically out of the question in a road vehicle required to make frequent stops, gear for starting and stopping must be interposed between the engine and the wheels of the vehicle. This gear is not so much of a nuisance as the hand labor in starting, but it is far from being an agreeable feature, and the running of the motor constantly when the vehicle is not in motion is an added expense and annoyance. On these and on other accounts *The Engineer* regards the motor car of 1896 as little more than "a gas engine in a cart," connected to the hind wheels and provided with some sort of steering gear. This is very far removed from such a degree of perfection as is necessary to bring motor carriages into general use. We entirely agree with this opinion. Nothing worth speaking of has been done in England in the way of road vehicles driven by electricity, and very little anywhere else. Steam has still a chance, and, we are inclined to believe, the best chance, but, in order to reach any degree of success in a steam-propelled road-vehicle, a radical departure from existing types of road-vehicles must be made. The difficulties in designing a good, commercially-practicable, self-propelled vehicle for public highways are very much greater than they were once thought to be, and a speedy solution of the problem is not at all probable.

Dr. Jacques's Cell.

AN article by Dr. William W. Jacques, entitled "Electricity Direct from Coal," in *Harper's Magazine*, is rather severely criticised by *The Electrician* (Dec. 11). The editor of that paper wields, on occasion, an excoriating pen, and he uses it unsparingly in his treatment of Dr. Jacques's article, or, rather, of the author's claims, since the article itself is characterized as "brightly written and readable," and the cuts illustrating it are alluded to as "telling." But these complimentary remarks are somewhat neutralized by the subsequent imputation that the article is "quasi-scientific," and that, as such, responsibility for it on the part of the publishers of a popular magazine extends no further than to the obtaining of the article from a reputed expert. The article having been "taken on trust" as to its facts, the author is to be held responsible "for anything wrong about it." Doubtless Dr. Jacques is sufficiently capable of replying to the criticisms made in *The Electrician's* editorial, which may be summarized as follows:

Extravagant deductions, the public dissemination of which may do mischief, are implied. The multitude of experiments claimed to have been made by Dr. Jacques are spoken of in a light vein, as though of small account, and the originality of the idea that, "if the oxygen of the air could be made to combine with the coal under such circumstances that the production of heat could be prevented, and at the same time a conducting path could be provided in which a current of electricity might develop, the chemical affinity of the coal for oxygen would necessarily be converted into electricity," is regarded as being confined to the notion implied by the word "necessarily." In Dr. Jacques's attempt to contest the assertion that the current obtained by heating carbon in fused caustic potassa is neither more or less than a thermo-electric current, it is noted that the thermo-electric effect which may arise from the cooling action of the air-blast is passed over without any attempt at refutation. The fact that Dr. Jacques mentions vessels of copper, lead, zinc, tin, aluminum, etc., as being destroyed by the action of fused caustic potassa is assumed to imply that he seriously supposed that vessels of these materials might practically answer the purpose; to demonstrate "ignorance of elementary principles of chemistry"; and to indicate "his degree of fitness for the formidable task of discovering a method of oxidizing carbon electrolytically." Dr. Jacques's explanation of the reason why, as alleged, vessels of iron used for holding the fused potassa give poor results as compared with those of other metals is called "dreadful nonsense." Without taking up cudgels in defence of Dr. Jacques, we venture to think that the causticity of this editorial will, at least partially, defeat its purpose. Perhaps the writer also thought that it might reflect unpleasantly upon himself, since, as prelude to his remarks, he enters a disclaimer of "prejudice against the deviser of new and unaccepted methods for the direct production of electrical energy," and asks to be believed when he asserts "that the mere manner and place chosen by an inventor for the exposition of his views" do not adversely affect the critic's judgment of the validity of the statements put forth. Whatever may or may not be the value of Dr. Jacques's alleged discovery; however much or little he may be entitled to credit for it,—these facts may surely be discussed without bitterness. Satire adds nothing to, and ridicule subtracts nothing from, a statement that must stand or fall according to its essential merits.

Roofs and Roofing Materials.

EXACTLY what has led up to the active discussion of roofs and roofing materials which has figured so prominently in engineering, architectural, and building literature for the past month, it is impossible to say. Elsewhere we have mentioned some articles on the subject that have appeared in American papers. These, with articles in the *British Architect* (Nov. 13) and the (London) *Architect and Contract Reporter* (Nov. 13), occupy about as much space as commonly could be found devoted to roof-construction in six months' or a year's issues of the papers named.

An abstract of a paper on "Slates," read before the first meeting of The Architectural Association of Ireland, held in Dublin November 11, is contained in the *British Architect*. The author makes mention of some of the chief sources of roofing slates,—America, Wales, Alsace, and France,—and notes some of the qualities of products of different quarries; but he deals principally with the Westmoreland and Cumberland slates. This paper gives an excellent *résumé* of the colors and qualities of slates from the different Westmoreland and Cumberland quarries, the sizes and thicknesses produced, comparative cost of different sizes, etc. With reference to sizes, we note that, whereas there were only three regular sizes fifty years ago,—to wit, twenty-four inches by twelve inches, twenty inches by ten inches, and sixteen inches by eight inches,—there are now some fifteen different sizes, ranging between the extremes of twenty-four inches by fourteen and sixteen inches by eight. This article, written by a practical slater, is full of sound, practical information, and may be consulted with advantage by all who desire reliable, up-to-date knowledge upon the subject of slates and slate-roofing.

Mr. F. Walker read a paper on "Tiles" on the same occasion, of which an abstract is also given in the *British Architect*. One of the points made in this paper is that the power to exclude dampness from dwellings and the power to withstand the disintegrating influence of weather go together in tiles. Density, toughness, and incipient vitrification are the characteristics of good roofing tiles. Tiles of a bright red or of an earthy red are, in general, absorbent, and do not weather well.

A curious and interesting fact relating to old tiles is mentioned by Mr. Walker,—to wit, that in some instances old tiles have been held at a higher market value than new ones, owing to an alleged acquisition of an artificial surface-coating that resists absorption. However, it is probable that esthetic considerations may have had some effect in holding up the prices of old roofing tiles. The best modern tiles are capable of effectually excluding dampness, if laid properly. The highly-fired brindled and blue tiles are most nearly non-absorbent. With reference to laying tiles, the author gives specific and detailed directions of value, but too comprehensive to permit of more than mention here, save in one important particular, relating to roofs of dormers and gables, which in tiled roofing should be given the same pitch as the main roof. If this is not done, purpose-made valley-tiles must be obtained, or resort must be had to lead gutters. Tile-makers keep valley tiles in stock only for roofs whose sides have equal pitch. Some awkward and unsightly results from the use of these stock valley-tiles are mentioned, and a great many other practical and interesting facts relating to tiles and tiled roofs are comprised in this excellent paper.

A third paper, entitled "Copper, Lead, and Zinc as Materials for Roofing," was read at the Dublin meeting by Mr. G. Ewart. Mr. Ewart ably set forth, as among the advantages of these metals, their availability for roofs nearly or quite flat, on which neither slates or tiles could be used. Their comparative lightness is also in their favor. For a given area slates weigh six to seven times, and tiles about fourteen times, as much as copper. Slates weigh four or five times as much as zinc, and tiles eight or nine times as much. Copper and lead roofs are very durable, while zinc occupies an intermediate position. Copper seems to take the lead in this particular. One of the most interesting parts of Mr. Ewart's paper is an account of the condition of some old copper roofs of notable buildings. The tower of the parish church in Hampstead was covered with copper in 1784, and is now in good condition. The copper which had been for two hundred and fifty years on an old church roof in Wiltshire was found imperfect only in the standing welts, which were worn. After trimming off the edges, the struts were relaid. On the whole, copper appears to be a better material than lead, requiring only about one-sixth the weight. It is resistant to fire and atmospheric influences, and requires much less support in ornamental work. It is less expansive under heat, and needs fewer drips. It is easily welted, and acquires a beautiful and permanent color after a few years of exposure.

If the three papers here reviewed are samples of the professional ability of the membership of the new association, it may hope to rank with the best of the architectural societies.

Internal Corrosion of Steam Boilers.

PERHAPS nothing in the whole field of steam engineering has been more puzzling to explain than the internal corrosion of steam boilers. This and that theory have been propounded. Some have supposed that in marine boilers a chemical action is set up, whereby the chlorine contained in the saline matter of sea-water is converted into hydrochloric-acid. Others hold that, if this were the case, at least some small amount of iron chlorid ought to be found in the water of a boiler; but Prof. Lewes declares that this is a substance never met with in water taken from boilers, and so the chlorhydric-acid theory appears to topple over. By far the most widely-accepted theory is that galvanic action is a potent cause, but there are many facts which seem to discredit this belief,—facts ably stated in a paper read before the Institution of Engineers and Ship-builders, in Glasgow last November, and published in *The Engineer* (London, Dec. 4). The author of the paper is Mr. Sinclair Couper, a managing partner in an extensive boiler works in Scotland, whose reputation for extensive study of the subject during a long practical experience in boiler building and repairing, and for careful examination of boilers after use, seems to have been sufficient to call out a notably large and representative attendance at the meeting for which the paper was announced. The theory which supposes galvanic action to be set up through differences in density of the metal was named. It is admitted that in laboratory experiments galvanic action may be set up, from differences in density of the metal and the use of different kinds of metal, as copper or brass, for tubes in iron or steel shells. But, nothwithstanding this fact, too much stress has been laid upon it, Mr. Couper thinks, in the endeavor to explain internal corrosion. We regret that we are unable to even outline this paper in the space at our command. It presents an unusually large array of facts. We can hope to secure for it only a somewhat wider attention than it otherwise might receive, and will note merely one of the many practical points presented in it, —namely, that much of the internal corrosion attributed to galvanic action, etc., is really caused by the liberation of free oxygen and free carbonic acid from the feed-water. Heat expels gases from their solution in water, and the gases so liberated attach themselves in the form of bubbles to the interior of the boiler, and act upon the metal at once. It is evident that the author regards this as a potent cause of internal injury to boilers. The corrosion is sometimes local (pitting caused by bubbles) and sometimes general, reducing the thickness of the plates with considerable uniformity. The variety of corrosion called pitting is often met with in feed-water heaters, from which the freed gases cannot escape as they do from a boiler from which steam is constantly being taken. As illustrating this point, the author, exhibited a corroded crown plate and manhole cover of a feed-water heater in which had been used only very pure fresh water taken from Loch Katrine. Where the feed inlet has been placed very low down, a similar action has been noted in steam boilers, particularly if the feed pipes are connected with a part of the boiler wherein the circulation is sluggish; and it is recommended that feed-pipes should be placed near the surface of water in boilers for the avoidance of this action. A very active and common cause of internal corrosion is the presence of fatty acids, sometimes introduced with the feed-water from streams of impure water, but more often passed into the boiler from the engine cylinders, where the oil from which they have been separated has been employed in lubrication. The paper reviews the subject exhaustively.

Combined Sail and Steam Power for Ships.

THE substitution of steam for sails in the propulsion of vessels resulted in the neglect of sail power, and the latter has apparently not received that amount of study as an auxiliary which it might have been profitable to give it. Only in comparatively few instances has steam power been studied as an auxiliary to sail power. A few years ago some vessels were built in the United States for whale-fishing, in which one of the masts was made of steel and hollow, to serve as a smoke stack, and a small auxiliary steam engine was placed on board to assist the sails when needed. This has also been done to a small extent in other countries. But there is no evidence that the problem of combining sail power with steam power in such manner that sails should become a part of the regular propelling power of a ship and an efficient aid to steam was ever made the subject of careful study. Either the sails have been regarded simply as helps to be relied upon only in case the steam engines were crippled or broken down, or, as in the case above cited, the engines have been regarded as helps to be used only when the wind is insufficient and in such emergencies as may arise in navigating seas more or less obstructed by ice. Now Mr. Carl C. Vogt, a Danish marine engineer, makes the propositions, first, that "a special construction of sails is necessary to work efficiently along with steam power"; and, second, that "it is a mistake to build steamers without properly-constructed sails, the greatest mistake of all being to build sailing ships with auxiliary steam power only intended for use in calm weather, because it is just when there is wind that the steam propeller acts to the greatest advantage in connection with properly-constructed sail power." These propositions are enunciated in a paper by Mr. Vogt in *The Steamship* for November, which also contains an account of an experimental study, made by permission of the Danish admiralty, with the frigate Fyer, to test the validity of the theory. The vessel has 2,740 tons' displacement, about 20,000 square feet of sail area (a Danish foot is equal to 1.029 feet English, and a Danish pound is equal to 1.098 pounds English), and 2,600 indicated horse-power of steam. A sample of the mode of investigating the subject follows:

The vessel one day, when moved by steam alone, was advancing at the rate of a little more than five knots, right in the face of a strong top-sail breeze of thirty-two feet per second, with corresponding sea. Her horse power at the time would have given her a speed of 8.5 knots in calm weather. Upon turning the ship 5½ points off from the wind, her speed rose to eight knots, without any increase of steam power. When gaff and stay-sails, having a total area of six thousand square feet, were put on, the speed rose to nearly ten knots. Comparing this with the horse-power of steam used in the experiment (540 h.p.), the power of the sails working in conjunction with the steam is computed to be 320 h.p. But, when the sails were used alone, the speed dropped to two and one half knots, which corresponds to only thirty h.p.

The difference between the power developed with sails alone, and that developed by sails working in conjunction with steam, was inferred from this to be more than three hundred h. p. The fact is accounted for by Mr. Vogt somewhat as follows: When the sails only were used, the vessel made a great deal of leeway, her sail area being insufficient to propel her at such speed as to effectually reduce leeway. When the steam power coöperated with the sails, there was scarcely any leeway. The making of leeway increases the resistance to forward motion. Mr. Vogt holds that, with sidewinds and winds before the beam, it is a mistake to regard sails as useless at high speed. He also holds that, although the sails of a windmill are generally of incorrect shape, they are, however, more nearly correct than the usual sails of a ship. Thus he compares the gaff sails of the Fyer with windmill sails. "At the mean speed of the wind a windmill of two sails requires an area of sixteen square feet for each horse power, whilst gaff sails, like those of the Fyer, require about thirty square feet at ten knots, and forty square feet at seven and one-half knots, the wind being a little before the beam. An effective horse power requires more than twice as much sail area." We cannot further follow the discussion, which proceeds to consider the application of combined steam- and sail-power to merchant vessels.

Electric Train Lighting and Other English Improvements.

THE compartment system, so long a feature of British railway passenger travel, clung to with a tenacity characteristically English, notwithstanding the deprecation of foreign travellers and critics, is evidently beginning to loosen its hold upon the affections of the English public. First, what the English call corridor carriages, with some compartments, of a size supposed to accommodate six passengers, three on either side when full, were placed on the main lines; but the compartments, when full, are not comfortable, it is said, and it is now announced in *The Electrical Engineer* (Dec. 4) that the South Eastern Railway Company has gone a step further, and has provided "a completely new express train, modelled on the American vestibule type, for the London-Hastings service." The convenience and comfort of this train will lead, no doubt, to a further extension of the system in England, and will much enhance the agreeableness of English railway travelling. It is interesting to note many features on these cars that are of American origin. The heating of the cars is effected by an independent Baker hot-water heating apparatus placed on each car. The ventilation is effected by adjustable louvres with ornamental panels placed between the alcove roof and the upper deck roof. Both in heating and ventilation, therefore, well-known American systems have been adopted. Last, but not least, each of the cars will be lighted by electricity, the current being derived from a dynamo driven by a link belt (another American contrivance) from a pulley on one of the car-axles. A mechanical novelty in the method of driving these dynamos is their regulation by belt-slip. We are not sure that this should not be called an unmechanical novelty, but, if it works well, as is claimed, it matters not what it may be called. Our contemporary describes this arrangement for maintaining a constant voltage independent of the speed at which the train is going, instead of allowing the speed of the dynamo to vary, and regulating the magnetic field, as follows: "The dynamo is suspended so that its weight gives the necessary tension to the belt. The weight of the machine and the torque on the armature then exactly balance each other at normal output. Any further effort causes the dynamo to be pulled near the driving-axle. This slackens the belt, and allows it to slip over the driving-pulley. Thus a condition of equilibrium is reached, and a further increase of speed is impossible." Below normal speed the current of the dynamo is reinforced by current derived from accumulators. The latter supply all the current during stops. A device is supplied whereby, when the car reverses its motion,—and, consequently, the motion of the driving axle,—the armature connections are reversed also. "An automatic switch, worked by a small governor on the shaft, closes first the shunt circuit and then the main circuit, as the speed increases to the normal," and contrariwise in slowing up. "The accumulators, which are of ample capacity, are placed in two wooden boxes under the carriage. One of these boxes is fixed on each side exactly under the center of the carriage. The lids of the boxes are easily reversed, giving access to the cell. There are sixteen of these to each car, the plates being contained in teak boxes." The current strength from the dynamos is thirty-five amperes at full load, and the lamps are, at a pressure of thirty-five volts, uniformly of ten candle power for each of the cars. Half of the lamps are left burning in the daytime, the surplus current being then used for charging the accumulators. A switch is placed in the attendants' recess, near which a small ammeter enables the current strength to be read at any time.

The "Stone" system of lighting cars, as here outlined, is said to be regarded with favor by railroad men, and to have proved very successful on the new London Hastings train of the Southeastern Railway.

The Rue De Tolbiac Bridge, Paris.

THIS bridge, which forms a viaduct over the Orleans railway in Paris near the terminal station, has peculiarities of construction which render it interesting from an engineering point of view, though it is not a joy forever as a thing of beauty. *The Engineer* (London, Dec. 25) presents a brief illustrated general description of this bridge (supplementary to a former illustrated detailed description previously noted in this magazine) with the remark that, "in point of unsightliness, it can even give odds to some of the British *chef d'œuvres* in that particular line," which is certainly a strong characterization of the inherent ugliness of the design. The bridge has been completed since the first description was published, and seems to meet all requirements except in the respect above mentioned. The prominent peculiarity of this bridge is that, while it has three spans resting upon the abutments and two intermediate piers, each is at a distance of 167 feet from its corresponding abutment,—these piers standing 197 feet asunder, center from center; the middle girders are 276 feet long, or 79 feet longer than the measurement between the centers of the piers that support them. Thus the opposite ends of the girders form cantilevers, each of which supports one end of its corresponding side girder, the other end resting upon the corresponding abutment. Each of these cantilevers projects toward the corresponding abutment a distance of 39½ feet. The central girders are irregular polygons, the bottom string-pieces being a considerable distance below the level of the bridge floor, which therefore shows through the lateral spaces. These lower stringers reach straight across between the central piers and then incline upward to a point somewhat above the floor level at the terminal of the cantilever. The stringers at the top of the girder extend the same distance and then incline downward at a less obtuse angle, to meet the lower part, but not in a straight line, each of these parts having an unsightly hump, the purpose of which is obscure, unless it is a part of a concerted scheme of asymmetry which appears to pervade the entire design. The junctions between the central and the side girders are in the nature of hinge-joints, or pivoted joints, and this principle is also extended to the connection between the main and the cross girders, which are practically hinged—not riveted or bolted—to the main girders in such manner that the ends of the cross girders may move very slightly in their own plane, according to the loads they are required to support and the degree of flexure to which they are subjected. It is claimed as a special advantage for this method of uniting the main and cross girders that, as it obviates deformation and distortion of the main girders resulting from the transference of loads to them by the cross girders, and as these forces are thus caused to be "purely vertical in character, the bracing is reduced simply to that required for resisting wind pressure." A notable feature of these queerly-shaped girders is the excessive length of panels, "which, in all those belonging to the central span,—except in the end bay or length,—reaches the formidable dimension of forty feet,—a regular girder bridge in itself. The longest diagonal strut—for, with the exception of four, all the inclined members of the web are in compression—exceeds by about a couple of feet a panel-length. These great lengths or bays are sub-divided or halved in the lower boom by the suspension stirrups which connect the upper pieces, where the web bars meet, with the middle points of the lower panels." Instead of the usual lattice bracing, horizontal plates are employed. Those desiring more minute detailed information will find in the two articles above cited all needful particulars.

Effect on Bridges of Motive Power at High Speeds.

THIS subject, having been brought under the consideration of the Association of Railway Superintendents of Bridges and Buildings, was referred to a committee consisting of Messrs. George W. Andrews, J. E. Grenier, and Walter G. Berg, which made its report at the recent meeting of the association in Chicago. The report is published in *The Canadian Engineer* for December, and doubtless will be disappointing to some who were active in initiating the investigation, if a mere compilation of facts and experience previously gained by others can properly be called an investigation.

In sum, the committee report that, up to the present time no positive law of the mechanical action and resultant effects upon bridge structures of motive power at high speeds has been formulated, and that it is impossible to even approximately indicate the injurious effects of quickly moving loads on bridges.

The committee, in effect, confesses ignorance of the quantitative values of increased strains to which bridges are thus subjected. At the same time it expresses the full belief that these effects can be measured, and that instruments can be made that will register them. This assertion, however, is accompanied, with the opinion that, in so broad a field no one committee can ever arrive at conclusions of great value. These statements are made the justification for the compilation embodied in the report as a substitute for the original matter which, the committee seems to think, was expected, since it solicits the indulgence of the association for the deficiency. Classifying attempted determinations of impacts into (*a*) purely theoretical, (*b*) those directed to measurement of the stretch of bridge members during the passage of trains, and (*c*) those directed to the measurement of the deflections of bridge structures as a whole, the committee declares that the theoretical determinations have no interest to the association. Those in class *b* include tests practically limited to European investigations on riveted bridges, which have shown that impacts on such structures decrease, as spans increase, "in a rather uncertain and erratic manner," and that "the impacts in the various members of the same span are a vague function of the moving load required to cause maximum strain in the member considered."

The instrument invented by Prof. S. W. Robinson for accurately measuring center deflections is favorably spoken of, as one means of obtaining accurate information in a general investigation of the subject. Members of the committee made about one hundred tests of the kind included in class *b*. The results are not included in the report, as they are said not to have been "sufficiently positive." The report well indicates the present imperfect knowledge of effects of impacts of moving loads on bridges.

THE FRENCH AND GERMAN PRESS

Basic Steel Rails.

PROFESSOR TETMAIER, of Zurich, has contributed to the *Schweizerische Bauzeitung* a series of articles examining very thoroughly the chemical reactions of the basic steel process and giving the results of his tests of basic steel rails, and the high authority in which he is held with regard to this subject renders these papers of much interest and value.

After examining the chemical reactions which enter into the basic process, Prof. Tetmaier describes the method of examining the structure of steel rails by the process of etching, giving careful instructions as to the cleaning and preparation of the section to be examined, this being substantially the same process that he described at the international congress in Zurich in 1895. The etching solution is composed of 100 grams of sublimed iodine and 200 grams of iodid of potassium in 1 liter of water, the operation taking from two to five minutes. If the etched specimen is to be preserved, it should be protected by a coating of toluol, or damar varnish. According to Prof. Tetmaier, the test by etching shows "that, with proper care as to temperature and final treatment, steel produced by the Thomas process cannot be distinguished microscopically from the most uniform, homogeneous, and flawless bessemer steel."

The etching test reveals the cause of many of the anomalies which appear in tensile tests, particularly as regards extension andcontraction of area. In many cases the etchings also show the reason why soft steel rails often exhibit greater uniformity as well as lesser amount of wear than harder steels under similar conditions. A number of photographic reproductions are given of etched sections of rails of bessemer steel as well as Thomas steel and Martin steel, illustrating the structure in a very clear manner, revealing especially the flaws of liquation and the presence of particles of slag.

The difference in the appearance of the central portion of the rail head and that of the surface which has to bear the wear of the wheels is marked in the etchings, and the chemical analyses of portions of metal taken from the exterior and interior of the rail heads show also a difference in many cases, as appears in a table of analyses of the sections photographed.

The paper concludes with an account of the tests required for Swiss railways, these being a drop test and a bending test, made upon whole rails, a rupture tension test made upon a machined piece taken from the head of a finished rail, and a chemical analysis.

European Grain Warehouses.

FOR some time there have been many complaints about the inadequacy of the facilities for handling and storing grain in Vienna, notwithstanding the fact that Austro-Hungary is one of the greatest grain-producing countries in the world. In order to be able to recommend the best method for overcoming the existing congestion, Herr Inspector Rischer was sent on a tour of inspection recently to see how things were done in other cities.

A generous abstract of his report appears in two recent issues of the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, and in it a number of interesting features are found.

Among other things it is shown that the Rhine country can obtain its grain more cheaply from Russia, or even from the United States or Argentina, than from the nearer grain fields of Austro-Hungary, simply because of lack of suitable handling facilities in the latter country. It was to the ports on the Rhine, therefore, that the Viennese inspector turned his attention.

At Mannheim and at Ludwigshafen were found elevators and conveyors, quite American in their appearance. Even the antiquated city of Worms has awakened to modern ideas in the last few years, and half a million dollars have there been expended on a fine stone elevator, with belt conveyors, electric lighting, etc., all operated by gas engines in the most approved modern manner.

At Mainz the matter of harbor improvements has been actively conducted for the past fifteen years, nearly $2,000,000 having been expended, partly in the construction of docks as well as warehouses ; and as recently as 1894 a new fire-proof elevator was constructed, costing over $100,000 for the building and $30,000 for machinery. Here all the machinery is operated by hydraulic power, produced by two steam engines of 80 h. p., which also furnish the electric light.

Cologne is, of course, an important port on the Rhine, being the dividing-point between the navigation of the Rhine steamers and the sea boats, and also being the great railroad frontier station into Germany. In the construction of the great grain warehouse at Cologne the difficulty of constructing dry storage vaults in a water logged soil was encountered, and it was only by the use of inverted arches over the entire foundation, lined with asphalt, that a water-tight cellar was obtained. At Antwerp there are several large elevators of the American type, and more are projected, while the admirable railway terminal facilities, in connection with the complete systems of hydraulic cranes and great series of docks, render this an excellent place for an inspector to pursue his investigations.

In reporting upon the best system for use at Vienna, Herr Rischer points out the differences between that city and those he inspected. Most of the Rhine cities have docks, while on the North sea, with its high tides, these are a necessity. At Vienna the principal obstacle is the rapid current of the river, making it most desirable that boats should be detained as short a time as possible. Hence he recommends at least three bucket elevators for each boat, so that the work of unloading may be most expeditiously performed, while in other respects he simply emphasizes the importance of the construction of modern internal details, belt and screws conveyors, hydraulic machinery, etc.

He was evidently much impressed with the operation of the Fairbanks automatic weighing machines, of which he speaks in admiring language.

It is apparent from this investigation that the grain fields of Hungary are likely soon to have the handicap of inadequate handling facilities removed, and the competition with America and Russia cannot fail to become closer and sharper when the new works at Vienna are completed.

Recent Swiss Turbines.

SWITZERLAND has undoubtedly made an enviable reputation as a country in which water is most successfully utilized, and hence the series of articles in the *Schweizerische Bauzeitung* by Prof. Franz Prásil, of the Zurich Polytechnic, reviewing the turbines and methods of regulation shown at the Geneva exhibition will be read with interest by American engineers.

All the great Swiss makers were represented at Geneva, including the firms of Piccard & Pictet (successors of Faesch & Piccard, who designed the Niagara turbines), Escher, Wyss & Co., Joh. Jak. Rieter, N. Bauhofer, Theodor Bell & Co., U. Bosshard, and the Ateliers de Construction Mécaniques, of Vevey.

A general predilection in favor of horizontal axis wheels is evident from the exhibits, the Girard and the Pelton types predominating. For lower heads, however, horizontal turbines were preferred, and some ingenious modifications of accustomed forms of both types were shown. In all forms, the influence of the demands of electric lighting appeared in the introduction of regulators of a much higher degree of excellence than heretofore attempted. In recognition of the necessity for close regulation of speed without great reduction of efficiency, the governors of the various exhibits form not the least interesting portion of their mechanism. In the vertical wheels the governing systems were nearly all based on a variation of the impinging stream by means of a variable mouthpiece operated by a set of differential hydraulic cylinders controlled by a centrifugal regulator. In order to secure the closest regulation, a differential system of lever connections is used, similar to the well-known "Davey" pump valve gear, by which the governor acts directly upon the turbine gate at one point in a lever and indirectly at another point through the medium of a hydraulic cylinder, the two movements opposing each other, and the connection of each acting as the fulcrum of the other.

This latter device is especially well developed in the high-pressure wheel of the Ateliers de Construction Mécaniques, of Vevey, and in the wheel of Messrs. Escher, Wyss & Co., of Zurich. Another ingenious form of regulator is that known as Schaad's "schalt" regulator, made by Messrs. Theodor Bell & Cie, of Kriens.

The principle of the device, the details of which are very skilfully worked out, is that of an independently-rotating member, which is maintained at the uniform velocity which it is desired that the turbine should maintain, and a ratchet connection between this and an adjoining member driven by the turbine. According as the latter gains or loses upon the former, the ratchet pawls which actuate the turbine gates are set in operation.

Among the horizontal turbines the most interesting exhibit is that of the installation of the electric-power station of the city of Geneva at Chévres. The wheels are arranged in pairs upon vertical shafts, the water entering above the upper wheel and below the lower one, and being discharged between them. The wheels themselves are conical in shape, in three sections each, and the automatic regulator acts, by means of differential hydraulic cylinders, upon a conical series of gates controlling the flow to the guide vanes. These wheels operate under a head varying from 28 feet in winter to 15 feet in summer, and, when the installation is completed, it will contain fifteen such turbines, each coupled direct to a two-phase generator of the Erreger type. Each turbine is of 150 h. p., and two sets are already in position.

Altogether, the exhibits at Geneva show the results of the effort of the hydraulic engineers of Switzerland to meet the demand for closer regulation and better adaptability to the present and future requirements, and Prof. Prásil's articles will be found valuable to turbine builders on this side of the ocean, as representing the latest practice of the best and most noted makers in Switzerland.

The Water Works of Bale.

In 1875 the city of Bâle purchased its waterworks from the company by which they had been constructed and operated since 1866, and from that time to the present successive improvements and enlargements have been made, some of which are of especial value and interest.

The source of supply originally consisted of a number of springs situated at Grellingen, in a valley of the Jura, about 15 kilometers distant. The maximum supply thus obtained, limited only by the capacity of the mains, was about 11,000 cubic meters per day, while the minimum has fallen as low as 2,500 cubic meters per day, this latter having been the case after a long drought in 1893.

In order to increase the supply, a steam pumping system was next constructed, taking the ground water from a gravelly water-bearing stratum found at "Langen Erlen," about 9 kilometers from Bâle, and the account of the development of this source of supply given in the *Schweizerische Bauzeitung* may present some points of value for similar plans in this country.

Experimental borings were made in 1878, and, the quality of the water being found satisfactory, an artificial spring was dug, from which a supply of 8,500 cubic meters was obtained in twenty-four hours; and, as this was kept up continuously for two weeks, it was decided to go ahead. Exploration borings showed that this spring drew from a radius of only about 250 meters, which seemed satisfactory.

The steam pumping station was started in 1881, the plant consisting of a pair of coupled direct-acting condensing engines and pumps. The steam cylinders of these engines are 23½ inches bore by 42 inches' stroke, the pump plungers having the same stroke by 10¾ inches diameter. The steam cylinders are provided with admission valves of the poppet type, and "grid-iron" exhaust valves, while the pump valves are of the so-called "*etagen-ventile*" variety, formed of annular rings arranged in a cone of steps. These engines operate at twenty-five to thirty revolutions per minute, and their united capacity is about 10,500 cubic meters per day.

The increased demand caused several new wells to be sunk between 1886 and 1894, and in the latter year the new waterworks, or, rather, the extension, was begun. Instead of repeating the installation of steam pumping engines, it was decided to try gas motors, using "Dowson" gas produced on the spot; and, as the new system has been placed in an extension of the old building, the two systems may be seen in operation side by side. The gas-producers stand in a room corresponding to the boiler room of the older plant, while the engine and its pumps adjoin the original steam pumping machinery.

The gas engine is a double cylinder motor of the Deutz Gas Engine Company's make, the two cylinders facing each other and the fly-wheel shaft lying between them. The cylinders are each 21 inches' bore by 30 inches' stroke, working at 140 revolutions per minute and developing 160 h. p. This engine drives a triple set of pumps, the pump shaft being connected to the engine shaft by a cotton rope transmission consisting of ten separate ropes, each 50 millimeters in diameter. The pump consists of three single acting plungers operated by cranks placed 120 degrees apart, the plungers being each 10 inches' diameter by 27½ inches' stroke, and the shaft making 60 revolutions per minute.

In tests made of the gas-engine plant last April, by Prof. Meyer of Zurich, there was shown a consumption of 0.86 kilograms of coke in the gas-producer for each actual horse power measured in water raised. This, of course, gives the efficiency of the entire plant, including the loss in the pumps. Separate tests of the pumps showed an efficiency of 96 per cent., so that the net effective power of the gas engine was obtained at a consumption of 1.81 pounds of coke per horse power per hour.

In the articles referred to there is much valuable information about the sinking of the wells, together with plans of the plant; the experience at Bâle may be found useful in discussing the introduction of gas motors in water works on this side of the Atlantic.

The Conception of Monumentality.

UNDER the above title, Herr Moritz Helder contributes an interesting essay to the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, reviewing the different modes in which the idea of a monument has been expressed in various ages of history. He shows that in the earliest ages the idea of a monument, as such, found its strongest expression, as in Egypt, both in tombs and in temples.

In Greece came the development of the monumental idea of the temple in its highest form, the influence of Greek art extending eastward in the colonies and westward to Rome. In Rome came an expansion of the monument, and we find the idea including all kinds of public works, arches, aqueducts, baths, palaces, all showing the waning influence of the old religion and the growth of materialism. In the east the ancient idea of a monument survived much longer, and from Assyria and Persia to India the temple and the tomb continued to be the objects of monumental art.

In the earlier times of Christianity the Roman influence predominated, but later the temple again became the great expression of the monumental spirit, as the works of the cathedral builders bear witness, until the advent of the Renaissance again brought secular art to the fore.

In modern times the attempts to express the idea of monumentality show an unfortunate tendency to return to the ancient forms of tombs or temples, but the high ideals of ancient times cannot be our ideals, and the attempts of modern architects to imitate the expression of feelings which to-day cannot exist is an injury to the best development of the art. For us the Roman development of works of utility combining the artistic conception of monumentality as well would be a far more truthful, as well as artistic, resolution of the problem.

A Hungarian Industrial Colony.

THE *Oesterr. Monatschrift* gives an interesting account of the industrial colony at Salgo-Tarjan, in connection with the coal-mining industry there. The number of men employed in the Salgo-Tarjan mines at present is about 3,800, and any man who is employed continuously is eligible to membership in the colony, which is practically a coöperative association for the provision of better dwellings, food, and clothing for the members. That something of the sort is necessary will be inferred from the fact that miners receive on an average but 1 florin and 68 kreutzers per day (about 80 cents), and laborers but 70 kreutzers (about 32 cents). The association has a capital of 1,500,000 gulden (about $700,000), and each workman pays into the common fund four per cent. of his wages, for which he receives as sick benefit his medical attendance and 30 kreutzers per day, During the past year the purchases of supplies for the coöperative account exceeded 500,000 florins (about $240,000).

The principal detail of interest, however, is that of the buildings, which are of three types. The earliest of them were built in 1870, and are much like large military barracks, except that they are divided into separate family apartments of two rooms each, a single building containing twenty of these apartments on each of its two floors, and thus accommodating forty families. There are nine of these large buildings, and five later ones of half the capacity, besides twenty one-story houses for two families each. For these accommodations a rent of 42 florins a year is paid, or about $20. The ground is well drained, and the property kept in good condition, and, according to the report of Herr Alois Meissner, from which the above is taken, the condition of the workmen and their families is far better than that of men in similar condition in life in other parts of the country.

Experience with the Fredereau Globes.

THE Fredereau globes for the better diffusion of electric lights have now been before the public for more than a year, and are beginning to be used in some important places. In a recent issue of *La Révue Technique* an illustrated account is given of their application to the illumination of theatres, the illustrations showing the theatre of the Cabourg casino and the theatre at Monte Carlo. The Fredereau diffusers, as is well known, are based on the principle of the Fresnel lighthouse condensing lenses, and are adapted for indoor use with incandescent electric lamps in a most effective manner. It is an understood fact that, with ordinary globes, either a large portion of the light is lost in attempts to reduce the glare, or else people's eyes are injured by the direct rays from the lamps.

At the Cabourg casino the Fredereau globes are so arranged as to cast much of the light upward against the reflecting ceiling, and the result is that, with only about one-half the number of lamps formerly used, the whole house is so well illuminated that a programme may easily be read anywhere. At Monte Carlo the diffusers are placed in the great chandelier, which was formerly most distressing to the occupants of the boxes by reason of the excessive glare. Since the diffusers have been in use, the candle power of the chandelier has been reduced by two-fifths without interfering with the effectiveness of the illumination, and the light is diffused generally over the entire auditorium, and the glare in the boxes relieved. In view of the progress which these globes are making in France, we may soon expect to see them in use in this country.

The Exposition of 1900.

ALREADY a portion of the preliminary work for the Exposition at Paris has been allotted, the first contract being that for fencing in the grounds on the right bank of the Seine, near the Pont des Invalides, and the second for grading and foundation work. Two of the French coöperative societies were bidders for a portion of the latter work, but they were decidedly underbid by a private firm which secured the work.

The plans for the new bridge across the Seine have also been submitted, and some local comment upon them will be found on another page.

The Development of Electro-Chemistry.

A VERY full review of the development of the advances in the applications of electricity to industrial chemistry during the latter portion of this century was made by Prof. Dr. Hugo Ritter v. Perger, in an address delivered recently before the Austrian Society of Engineers and Architects, and reprinted in the *Zeitschrift des Oesterr. Ing. u. Arch. Vereines.*

Dr. Ritter v. Perger gives a historical review of the earlier applications of the electric current from the time of Jacobi's discovery of galvanoplasty,—which Oettel calls the beginning of electro chemistry,—referring to Ostwald's history of electro-chemistry, Jahn's mathematical treatment of the subject, and the practical works of Le Blanc, Lupke, Borchers, Arens, and others.

He then takes up the more recent applications, and gives a rapid examination of the later developments of electro-chemistry, particularly with regard to the electric separation of metals, both by electro-decomposition and by the electric furnace.

The article refers also to the changes in metallurgy and industrial chemistry likely to be wrought by the use of natural forces, such as hydraulic power, to generate the electricity, and concludes as follows :

"Within a few years a new art has arisen,—an art of which the extent is so great and the consequences so far-reaching that it is impossible for us to predict the immense changes which the coming century may see in the chemical industry; changes which will be not less momentous in a commercial sense than those which followed the development of the steam engine.

"With the increasing development of water power, industrial centers of a new kind will arise. Coal, that mighty accumulation of power, will be largely replaced by the force of moving water acting upon swift running turbines, as in the past coal was compelled to give up its energy by means of boiler and engine, or gas was harnessed in the gas engine.

"The consequences of this tireless action of natural force we to day can at least partially understand and foresee. The milestones of this eventful century,—photography, spectrum analysis, the production of dyestuffs by organic synthesis, bacteriology, electro-technics,—all these are crowned by the final triumph of the development of electro-chemistry, by no means the least of the advances in the progress of scientific discovery."

The Distribution of Pressure in Piers.

HERR RUDOLF MAYER, of Vienna, contributes a valuable article to the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, showing that the customary idea that the pressure of a pier upon its foundation is uniformly distributed over the entire area is subject to revision.

If we imagine the foundation of a pier to be composed of some elastic, yielding material in layers or courses of constantly-increasing area, we see that the weight of the pier would cause the sole of the foundation to bend down in a convex shape, the pressure being at a maximum directly beneath the axis of the pier and diminishing outward in all directions. When the foundation is composed of a rigid material, this diminishing distribution of pressure still exists, and Herr Mayer shows by diagrams the rate at which it diminishes with each course of the foundation masonry. Thus, for a foundation of 10 courses of stone stepping out uniformly from the base of the pier downwards, it is shown that 75.4 per cent. of the load is borne by that portion of the foundation directly beneath the projection of the base of the pier, while 12.3 per cent. is carried by the outer portion.

Following out the same analysis, it is shown that, no matter how deep the foundation is carried, the minimum pressure carried by the lowermost course directly under the axis of the pier is 50 per cent. of the pressure at the top of the foundation.

Finally, the author deduces the law that, for tall piers, the point at which the relative load upon that portion of the foundation which lies directly under the vertical projection of the pier reaches the minimum of 50 per cent. is found at a depth of foundation equal to one-half the height of the pier.

The Pneumatic Pumping of Sewage.

AMONG the matters of interest connected with the industrial exhibition at Berlin the handling of the sewage of the exhibition grounds is worthy of special notice; the following description is extracted from a general article by the engineer, Herr Heinrich Koechlin, in the *Oesterr. Monat. f. d. Oeffent. Baudienst.* for December.

On account of the low level of the exhibition grounds and the high condition of the ground water beneath, a gravity system of sewerage could not be employed, except at very great cost, and, as in the adopted system of sewers the outlet was about five meters above the level of the plateau on which the buildings were placed, it was necessary to use some form of pumpage.

The method employed was that of pneumatic pressure, as this met the local difficulties in the simplest and least expensive manner, and enabled the collector to be of small dimensions with good slopes; the plans of the firm of Erich Merten & Co., of Berlin, were adopted.

Twenty-two ejector stations were constructed each in a pit about 3.5 meters deep, the depth being chosen so as to give a fall to the collectors of one to two per cent. The flow of sewage is collected in each pit in a cast-iron tank, a float in the tank rising as the latter fills; as the float reaches the top, it opens a valve, admitting compressed air, and the contents of the tank are forced through the discharge-pipe. The valves in the inlet and outlet pipes are large flaps, which appear to have given no trouble, the inlet pipes being of glazed earthenware and the discharge of cast iron.

The total capacity of the collectors is about two hundred cubic meters per hour, which is nearly double the actual requirements of the exhibition, since the maximum discharge per day during the months of June and July was only about 3.300 cubic meters. The compressed air for all the collectors was furnished from a central station near the main entrance to the grounds, an air pressure of five atmospheres (about seventy pounds) being maintained by a direct-connected steam compressor. A pair of Cornish boilers, having a heating surface of 60 square meters (646 square feet) each, are also in use, one being for the air compressor and the other for use in connection with the water-supply.

The entire installation seems to have been most satisfactory in operation, and the system appears to be especially well adapted for the temporary use to which it was applied.

An Extensive Train Yard.

THE new train yard at Friedrichstadt, for operation in connection with the railway station at Dresden, in Saxony, is an important piece of railway improvement; the following points concerning it, taken from the *RévueGénérale des Chemins de Fer*, will be of interest. The system is to be composed of sixteen tracks, of which eleven are now constructed and in use, three round-houses, and a most extensive system of switches and turn-outs, the whole aggregating about 76.7 kilometers of track (about 48 miles). The yard is 2,500 meters long by 300 wide, and the total cost is estimated at about 8,000,000 marks. The arrangements for making up the trains is most complete, relieving the station in Dresden and greatly facilitating the entire work. The yard has a capacity for 4,000 cars, although the greatest number yet reached is about 2,500.

Russian Patents.

THE new Russian patent law, among other changes, forbids the granting of patents at all to inventions relating to articles of education, chemical compositions, medical, food, or health preparations, or for trifling improvements in existing inventions; although it is not said by whom the importance of an improvement is to be decided.

The duration of a Russian patent is to be fifteen years, unless terminated by the expiration of a foreign patent on the same invention, and there is a sliding scale of yearly fees during the whole term of the patent, beginning with 15 rubles for the first year and increasing to 400 rubles for the fifteenth year.

Electric Plants for Small Towns.

An editorial in the *Deutsche Zeitschrift für Elektrotechnik* sounds a warning to the authorities of small towns against the too hasty installation of local electric-lighting plants.

Most towns already possess gas works, and it cannot be assumed that the electric light will entirely displace gas, especially for lighting dwellings of moderate size; hence the electric-light concern must count on the active competition of gas in many places. In large cities the best customers of the electric companies are the theatres, restaurants, great shops, and the like, but these form but a small portion of the life of a moderate-sized town, and even in residences the hours of lighting are by no means so extended as in the large cities.

In considering the introduction of an electric plant, therefore, the character of the place should be taken into careful consideration. If the town is well supplied with manufacturing industries, the demand for light is likely to be greater, while in an agricultural neighborhood, or one in which quiet residences predominate, an electric-lighting venture is likely to prove a disastrous investment.

While the conditions in this country are by no means the same as in Germany, yet experience has taught some dear lessons here also, and the above considerations are not without value.

The New Bridge at Berne.

For some time a new high-level bridge has been under discussion at Berne, and in the *Schweizerische Bauzeitung* is given a description of the details of the final designs submitted and the award of the contract, so that the new structure will soon be well under way. It is to consist of a single great iron arch of 112.5 meters' span, and 33.5 meters' rise, springing across the valley of the Aar, with truss approaches connecting with the high plateaus on each side.

The roadway is to be supported on each side by massive piers of masonry, and the magnitude of the work, as well as the constructive difficulties connected with the deep foundations of the piers, renders the subject an important and interesting one.

Three designs were submitted in the final competition, all closely resembling each other, as was necessarily the case from the precise nature of the specifications issued. The perspective views given in the articles referred to show that the bridge will be a most effective addition to the city from an artistic standpoint, as well as a useful one, and that it will not suffer in comparison with the great stone arch of the Nydeck bridge, near by.

The contract was awarded, after some modifications, to the firm of Theodor Bell & Co., of Kriens, and the structural work will be executed by the well-known Gutehoffnungshütte, of Oberhausen, the other competitors being Alb. Buss & Co., of Berne, and the *Societa Nazionale delle officine de Savigliano*, of Turin.

The work is to be completed in 1898, and the total contract price is 1,754,000 francs, or about $350,000. The detailed study of the plans by Herr H. v. Linden, city engineer of Berne, in the articles above mentioned, is very full. The commission by which the competing plans were examined consisted of Col. Edward Locher, well known as the engineer of the Pilatus railway, and professor in the Zurich Polytechnic, W. Ritter, and Conrad Zschokke, the last two being well-known engineers.

Tests on a 160-h.-p. Gas Engine.

Such a test was carried out by E. Meyer, of the Royal Technical High School in Hanover, on a power station with coke generators for gas and waterworks at Basel. The low consumption of coal for the work done has caused considerable interest to be taken in the gas engine. The high pressure produced in the engine cylinders, especially if these are large, causes a great strain on the moving parts, thus making the large horse-power gas engine difficult of construction, and, as Mr. Meyer states, not very much more efficient than some good, but small, gas engines. The *Zeitschr. des Vereines Deutscher Ingenieure* gives the results of this work in detail in its issue of October 24.

The Supporting Power of Soils.

THE *Schweizerische Bauzeitung* illustrates a simple apparatus devised by Herr Rudolf Mayer for measuring the capacity of any given soil to support a load, such as the pressure of a pier or foundation.

Briefly, the device consists of a plunger fitting in an open-bottomed cylinder, so arranged that the bottom of the plunger rests upon the ground, while a platen upon the top may be loaded with weights. A large base plate prevents the surrounding earth from being forced up around the plunger, while the depth to which the latter sinks upon the application of a given weight is measured by the rise of a column of mercury, forced by an auxiliary plunger. Closer measurements are made by a micrometer, and various minor details of construction are clearly exhibited in a drawing.

The principal criticism which may be made of this device is its small size. The one illustrated has a plunger of only 20 square centimeters in area, or about 2 inches in diameter, and it seems unlikely that so small an area of any given piece of ground could give results from which any trustworthy conclusions could be drawn. By using similar apparatus upon a large scale, and repeating the observations at many points, doubtless reliable information could be obtained, but even then much would depend upon the care and judgment of the observer.

Portable Petroleum Motors.

AT the Geneva Exhibition a number of petroleum motors were exhibited, such motors being more and more used in Switzerland in printing and other small manufacturing work, such as the making of parts of clocks, watches, and the like.

Among these motors was shown a portable petroleum engine of six horse power, intended for agricultural purposes, the principal advantages claimed being lightness and freedom from destructive explosion. According to *La Révue Technique*, these Swiss motors develop a horse power with a consumption of 400 to 500 grams (0.88 to 1.1 pounds) of crude petroleum per hour.

The Resistance of Ships.

PROF. MARYNIAK, of Lemberg, has deduced a formula for the resistance of ships, based on the theoretical principles of hydrodynamics, using for the determination of the constants the experiments of Froude on the Greyhound. According to the applications given in Prof. Maryniak's article in the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, the resulting formula gives results agreeing very closely with the actual determination by speed trials. The mathematical analysis and the detailed examples are worked out in full in the article referred to, which is in the issue for December 4, 1896.

The New Bridge Across the Seine.

OBJECTIONS are being urged against the construction of the new bridge across the Seine at Paris, commonly called the bridge of the exposition, but which, we believe, is to be named the *Pont Alexandre III.* A writer in *La Révue Technique* calls attention to the already obstructed condition of the river, and indeed it would seem that there are already bridges enough. Within the limits of Paris there are now thirty-four bridges across the Seine, of which twenty three span the main stream and eleven cross the narrow channels around the islands of the *Cité*, *Saint Louis*, and the *Cygnes*. In several instances the piers of one bridge are nearly in line with the openings of the one next above, and the action of the current tends to throw vessels directly against the artificial obstructions thus formed, causing many and sometimes serious mishaps.

The commerce traversing the river at Paris is much greater than one would imagine, aggregating 3,400,000 tons in 1895, not including the swift passenger boats which every visitor in Paris remembers as a characteristic feature of the river; and it can well be understood that the interests involved in the river navigation should desire no further obstruction to the channel.

It is proposed to place the new bridge only about 200 meters from the present *Pont des Invalides*, and to make it a single steel arch, hinged at the crown and springings as was the roof of the Machinery Hall at the exposition of 1889, and as the *Pont Mirabeau*, just completed, is constructed. The bridge is to be 40 meters wide, thus forming a veritable tunnel over the river, and, while there will be no piers in the stream, yet it is urged that this overshadowing arch will be a serious inconvenience to navigation.

La Révue Technique urges that the bridge should be considered from one or the other of two standpoints,—either as a permanent improvement to the city, or merely as an adjunct to the exposition.

From the latter consideration it should not for a moment be permitted to stand in the way of the important commerce above mentioned, while, in view of the former, it is quite unnecessary.

Finally, it is urged that, if the plan for the bridge must go through in its present shape, the scheme should also include a reconstruction of the *Pont des Invalides*, in order to avoid the threatened dangers.

The Mammoth Globe at the Paris Exposition.

THE project of M. Borgel-Court to construct at the Paris Exposition of 1900 an enormous structure in the form of a geographical globe 150 meters in diameter quite casts into the shade both the Eiffel tower and the Ferris wheel. Those who visited the Paris Exposition of 1889 remember the globe there shown, which, however, was only about forty-two feet in diameter, one millionth of the earth's mean diameter, and was intended solely as a geographical exhibit.

The proposed monstrosity, as described and illustrated in *La Révue Technique*, however, is a far different affair. It is to contain upon its five interior floors representations of all the various countries in the world. The visitor is to be transported by electric railways from one country to another in such a manner that, in traversing the interior of the structure, he will practically visit every country on earth (apparently with the exception of Germany), finishing, of course, at a restaurant on the platform on top.

The entire cost of the proposed globe, including the expenses of operation during the exposition, is estimated at ten million francs, but whether or no this extraordinary project will ever be realized we cannot say. The scheme is as yet only on paper, but, when we remember the short time required for the construction of the Ferris wheel, we must not say that the time is too short to insure us safety from this impending nightmare.

Some Belgian Machine Tools.

LA RÉVUE TECHNIQUE gives several illustrations of machine tools made by the establishment of Messrs. Loewe, of Herstal, near Liege, which, if they were not distinctly labelled, would certainly be taken for machines of American make. The planers, shapers, and automatic screw machines are so close copies of the tools familiar to the American machinist that we cannot help wondering if they are not like some others of which we have heard,—"just the same, only one shrinkage smaller"! The *Révue Technique* is evidently of the same way of thinking, although to another end, for the comment is rather as to the influence which the American method of tool-specialization will have upon the future of the machinist himself. "Whether this tendency be for good or evil we are not now prepared to say," the critic proceeds, "but, if the principle is conceded, it is certain that these tools exhibit the highest degree of perfection." The writer, after describing in detail machines with which every American mechanic is entirely familiar, concludes by saying that the success of such an exhibit at the exposition of 1900 is already assured. Admitting the justice of the tribute, we only add that we trust the honors will then be given to the originals, and not to the copies.

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Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées *m.* 31 francs. Paris.
Architect, The. *w.* 26s. London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $.4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30s. Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m* $5. New York.
Bankers' Magazine. *m.* 18s. London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23s. 8*d.* London.
Builder, The. *w.* 26s. London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27s. 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Dingler's Polytechnisches Journal *w.* 43.60 marks. Stuttgart
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19s. 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago
Electrical Plant. *m.* 6s. London.
Electrical Review. *w.* 21s. 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrochemische Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 20 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36s. London.

Engineers' Gazette. *m.* 8s London.
Engineering. *w.* 36s. London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
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Garden and Forest. *w.* $4 New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
India Rubber World. *m.* $3. New York
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
La Nature. *w.* 24.50 francs Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w* 45 fr. Paris.
L'Électricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer's Record. *w.* $4. Baltimore
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Mining Industry and Review. *w.* $2. Denver.
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Mining Journal, The. *w.* £1. 8s. London.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Municipal Engineering. *m.* $2. Indianapolis.
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New Science Review, The. *qr.* $2. New York.
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North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London
Popular Science Monthly. *m.* $5. New York
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Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1 New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
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Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York
Seaboard. *w.* $2. New York.
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Street Railway Journal. *m.* $4. New York.
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Technology Quarterly. $3. Boston.
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Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
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Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *yr.* Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
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ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

9656. The Stimulus of Competition in Architectural Construction. Dankmar Adler (Showing the function of architecture and how departure therefrom may work ill to industry and commerce). Eng Mag —Jan. 3,300 w. 30 cts.

9772. Repairing and Reinforcing Foundation Piers (Describes work found necessary in a recently constructed large office building in New York. Illustrations are given and methods explained). Eng Rec —Dec. 12, 1896. 1,200 w. 15 cts.

9775. Structures Over the Eastern Ends of Some English Churches, and Suggestions They Offer for Modern Treatment (Discusses suggestions that have been offered in explanation of this feature, with illustrated description of examples). Builder—Dec. 5, 1896. 2,000 w.

9776. Trussed Roofs. F. E. Kidder (The writer proposes to describe the different methods of supporting roofs by trusses, the mechanical principles involved in the construction of trusses, the way in which the stresses and size of the pieces are determined and how they should be put together. Illustrated). Arch & Build—Dec. 12, 1896. Serial. 1st part 2,500 w. 15 cts.

9777. Dangers of the Sky-scrapers. Extract from N. Y. Sun (Chief Bonner's explanation of his opposition to high buildings before the committee appointed by the Board of Trade and Transportation). Arch & Build—Dec. 12, 1896. 1,600 w. 15 cts.

9789. The Proposed New Government Offices. H. Heathcote Statham (A criticism of public buildings erected in England, and attributing most of the blunders and mistakes to imperfect understanding on the part of Parliamentary committees). Fortnightly Rev—Dec., 1896. 6,000 w. 45 cts.

9820. Grain Storage Warehouse (Ueber Speicher und Umschlags-Einrichtungen). Paul Kortz (Two articles containing the substance of a report of Herr Anton Rischer, City Inspector of Vienna, after an inspection of the various systems of grain handling and storage in various cities prior to local improvements. Accounts are given of the methods used in Ludwigshafen, Mannheim, Worms, Frankfurt, a. M., Mainz, Köln, Duisberg, a. Rh. Ruhrort, Uerdingen, Antwerp, London, Liverpool and Budapest. A most interesting account of Continental systems). Z. Oesterr, I. u. A. V.—Nov. 27 and Dec. 4, '96. Both articles 10,000 w.

9825. The Laws of Buckling for the Most Important Materials of Construction (Die Gesetze der Knickungsfestigkeit der Technisch Wichtigsten Baustoffe). Ingenieur Paul. (Formulae for the resistance of long and short pillars of various materials, based upon the recent experiments of Prof. L. v. Tetmaier, at the Zurich Polytechnic). Z. Oesterr, I. u. A. V.—Nov. 27, '96. 1,500 w.

9828. Architecture. An essay, with reference to the Geneva Exhibition (Exposition Nationale Suisse à Genéve. Essai d'Architecture). M. Louis Viollier. (A discussion of the relations of the artistic and constructive sides of architecture, suggested especially by the Geneva Exposition. Two plates of interiors). Schw. Bauz—Oct. 3 and 10, '96. 1,500 w.

9829. New Evangelical Church at Wiedikon-Zurich (Die Neue Evangelische Kirche in Wiedikon-Zurich). Paul Reber. (Description, with plate and cuts). Schw. Bauz—Dec. 5, '96. 1,000 w.

9830. New Secondary School House in Zurich (Das Neue Sekundar Schulhaus in Zurich). A description, with plate of an excellently arranged school house in probably the best educational centre in Europe). Schw. Bauz—Dec. 12, '96. 800 w.

9831. The New Palace of Justice at Budapest (Der Neue Justiz-palast in Budapest). A brief description, with plate and plans of the rather showy design of Prof. Haussmann, commenced in 1893 and finished last August). Arch. Rundsschau. —Nov. 2, '97. 500 w.

9832. Apartment House in Vienna (Zinshaus in Wien). Ign. Sowinski (Plate, plan and brief description of an apartment house in the modern showy Viennese style). Oesterr. Monatschr. f. d. Oeff. Bau—Dec., 1896. 200 w.

9834. Concerning the Computations for Beton-Iron Construction (Ueber die Berechnung der Béton-Eisenconstructionen). J. Melan (A valuable mathematical treatment, taking into account the relative elasticity of iron and beton, and written by the inventor of this much-discussed system of construction). Oesterr. Monatschrf. f. d. Oeff. Bau—Dec., 1896. 3,500 w.

9836. The Conception of Monumentality. (Ueber den Begriff der Monumentalität). Moriz Heider. (An essay showing the different ideas which existed in successive ages as to the proper expression of the idea of a monument and criticising the present treatment of the subject.

9842. The Tomb of Ibrahim Adil, Shah of Bidschapur. (Grabmal des Ibrahim Adil Schah zu Bidschapur). (Perspective sketch and detail of a Hindu tomb of the mosque order). Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Dec. 25, '96. 800 w.

9849. The Tower of the World at the Exposition of 1900. (Le Tour du Monde à l'Exposition de 1900.) (An illustrated description of the monster globe which it is proposed to construct to outdo the Eiffel Tower). La Révue Technique—Nov. 10, '96. 2,500 w.

9932. The "Standard" Buildings, Calcutta (A short description of a beautiful piece of architectural engineering, with illustrations). Ind & East Eng—Nov. 14. 1,300 w. 45 cts.

10023. The Underpinning of Heavy Buildings. Jules Breuchaud (Illustrated description of a novel method recently adopted for the support of heavy buildings. The foundation work for the Commercial Cable Building, twenty-one stories high, at Broad and New sts., New York City, is described, with the method for preventing damages to adjacent buildings). Am Soc of Civ Engs—Dec., 1896. 2,700 w. 45 cts.

10042. The Structural Framework of the Astor Hotel, New York City (Illustrated description of the principal details of the structural work of the new Astor Hotel, now being erected at 5th ave. and 34th st.; also editorial). Eng News—Dec. 24, 1896. 4,000 w. 15 cts.

10053. High Buildings (Objections as presented in discussion before the Board of Trade). Fire & Water—Dec. 26, 1896. 1,800 w. 15 cts.

10086. The Great Mosque of the Omeiyades, Damascus. R. Phene Spiers (Illustrated description of the actual buildings of the Mosque and their adjuncts as they existed prior to the fire of 1893; a brief sketch of the history of Damascus so far as it relates to these buildings, with a research into the dates and original plan of the earlier remains, and some account of the damage done by the last fire). Jour of Roy Inst of Brit Arch—Nov. 19, 1896. Serial, 1st part. 7,500 w. 30 cts.

10116. Construction Details and Testing of a Fireproof Floor System. A. L. A. Himmelwright (Illustrated description of construction and tests of the Roebling floor system). Eng Rec—Jan. 2, 1897. 2,500 w. 15 cts.

10117. The Regulation of Tall Building Construction (Summary of the regulations in force in the cities of Continental Europe regarding the limitation of the height of buildings, as submitted by President Wilson to the Board of Trade and Transportation of New York City). Eng Rec—Jan. 2, 1897. 1,200 w. 15 cts.

10122. Model Apartment Houses (Drawings of accepted designs to be built by the City and Suburban Homes Company, with description). Arch & Build—Jan. 2, 1897. 900 w. 15 cts.

10158. Oxford Municipal Buildings (Brief record of the materials employed by the architect in the construction). Brit Arch—Dec. 18, 1896. 1,800 w. 30 cts.

10161. Steel Skeleton Construction (Abstract of paper read at meeting of Civ. Engs., England, by E. C. Shankland on "Steel Skeleton Construction in Chicago"). Col Guard—Dec. 24, 1896. 1300 w. 30 cts.

10186. St. Joseph's College, Colombo (Illustrated description of the Roman Catholic College in Ceylon). Ind Engng—Dec. 5, 1896. 1,500 w. 45 cts.

10207. Model Lodging-Houses for New York (Brief description of great improvements in this class of buildings in Glasgow, Manchester, London and other European cities, and now being made in New York. Illustrations of designs of Mr. Ernest Flagg now being built by Mr. D. O. Mills). Rev of Revs—Jan., 1897. 1,500 w. 30 cts.

10290. Pneumatic Caisson Foundations for the Gillender Building, New York City (Illustrated description of an interesting foundation work recently erected at the corner of Wall and Nassau sts., N. Y.). Eng News—Jan. 7, 1897. 1,500 w. 15 cts.

HEATING AND VENTILATION.

9686. Ventilation Practically Considered (An extract on the heating of school buildings from a work published by Rufus R. Wade). Met. Work—Dec. 12. 3,800 w. 15 cts.

9920. Heating and Ventilation of the Atchison, Topeka and Santa Fe Railway Hospital (Illustrated description of the building and its fan system of heating). Heat & Ven—Dec. 15. 900 w. 15 cts.

9921. Ventilating and Warming Stables (Considers the proper area of floor space for stables and also the cubic space, and the quantity of fresh air required both summer and winter). Heat & Ven—Dec. 15. 1,800 w. 15 cts.

9922. The High Pressure System of Heating in England. Frederick Dye (Explains the system which, in England, is considered for certain purposes to excel all others). Heat & Ven—Dec. 15. 1,800 w. 15 cts.

9944. Heating and Ventilation of the Central High School, Detroit, Michigan (Illustrated description). Eng Rec—Dec. 19. 1,800 w. 15 cts.

10045. Heating and Lighting with Mineral Oils. Dr. Stevenson Macadam (Abstract of paper read at the Royal Scottish Soc. of Arts. Discusses the dangerous character of oils, to what due, and the requirements for safety). Arch, Lond—Dec. 18, 1896. 1,800 w. 30 cts.

10119. Heating of a Medford, Mass., School (Illustrated description). Eng Rec—Jan. 2, 1897. 1,200 w. 15 cts.

10136. The Warming of Buildings by Hot Water. Ernest King (Read before Inst. of Junior Engs. Part first considers the low-pressure system, in which the water in the apparatus is at one or more points open to the atmosphere).

Prac Eng—Dec. 25, 1896. Serial, 1st part, 1,000 w. 30 cts.

LANDSCAPE GARDENING.

9731. Landscape Engineering in Connection with an Engineer's General Practice. W. K. Eldridge (Showing how the study and thorough knowledge of landscape design and management is helpful to the engineer). Purdue Soc of Civ Engs—1896. 5,500 w. 45 cts.

10087. Landscape Effects at Kew. W. W. (An account of the picturesque scenery produced in this botanical garden. Illustration). Gar & For—Dec. 30, 1896. 700 w. 15 cts.

10204. The Planting of Shrubberies (Editorial commending a pamphlet issued by Prof. Bailey of the Cornell Experiment Station, entitled "Suggestions for the Planting of Shrubbery," and commenting briefly on the subject in general). Gar & For—Jan. 6, 1897. 1,200 w. 15 cts.

PLUMBING AND GAS-FITTING.

9712. Construction of Drains E. C. Lynde (From a paper read before the Incorporated Assn. of Munic. & Co. Engs. Deals with improved methods of drainage construction). San Plumb—Dec. 1. 1500 w. 15 cts.

9713. Gas-fires and Gas-stoves. W. Grafton (Discusses some of the principles involved in the manufacture of gas-fires, and where to look for failures should they occur). San Plumb—Dec. 1. 1,700 w. 15 cts.

10120. The Hefner Standard Lamp (Conditions of test of the lamp, with its description in the form in which it is admitted to standardization, &c.). Pro Age —Jan. 1, 1897. Serial 1st part. 2800 w. 15 cts.

10143. The Process of Lead Burning. G. A. S. (Gives history and advantages of the system and describes the process. From "The Building World"). Dom Enging—Dec., 1896. 900 w. 30 cts.

10144. House Plumbing. Henry N. Ogden (Read before the Tompkins County Medical Society, at Ithaca, N. Y. Illustrated discussion of sanitary plumbing). Dom Enging—Dec., 1896. 2500 w. 30 cts.

10185. Advantages of Main-trap and Fresh-Air Inlet in House Drainage. J. J. Cullington (Discusses precautions necessary to have plumbing safe). San Plum—Jan. 1, 1897. 2000 w. 15 cts.

MISCELLANY.

9725. Progress in Sanitary Engineering. Andrew Noble (Address as President of the Section of Engineering and Architecture of the Congress of the Sanitary Institute, at Newcastle-on-Tyne. General discussion dealing with various branches). San—Dec., 1896. 5,000 w. 45 cts.

9732. Fireproofing as a Specialty. Joseph K. Freitag (Facts showing the drain on our national resources from fire losses and the expenses arising from them, and that proper fire protection must soon be recognized as a distinct branch of engineering). Purdue Soc of Civ Engs. 1896. 3,000 w. 45 cts.

9787. Electric Wiring. Thomas W. Flood (Read before the Boston Society of Architects. The necessity for architects to make provision in their plans for the electrical installation. Different classes of electrical work and their requisites). Am. Arch—Dec. 12, 1896. 2,000 w. 15 cts.

9823. Notes on the Building Exhibits at the Berlin Technical Exposition of 1896. (Der Hochbau auf der Berliner Gewerbe-Austellung, 1896.) Heinrich Koechlin (A brief notice of the exposition, followed by a review of the building trades exhibits, mainly of interior details. An account of the compressed air apparatus for removing the sewage from the exhibition is also given). Oesterr. Monat. O. B.—Dec., 1896. 12,000 w.

9824. Notes on the Graphical Computations of Frameworks. (Beitrage zur Graphischen Berechnung des Fachwerks). L. Geusen (A combination of Ritter's method of sections and moments, with the modern polar graphostatic diagram). Z. Oesterr. I u A V—Nov. 20, 1896. Diagrams and 2,000 w.

9910. Terra-Cotta (Ill.). William F. Jelke (History of the industry and its successful application for architectural purposes). Yale Sci M—Dec., 1896. 1,900 w. 30 cts.

9947. Instruction in Architectural Drawing. William R. Ware (Revised copy from original in "School of Mines Quarterly." Part first deals with tracing and copying, giving many illustrations). Stone —Dec., 1896. Serial. First part. 2,400 w. 30 cts.

9969. Street Architecture. H. H. Statham (The architectural problem arising from the necessity of planting buildings as closely as possible together in cities is considered. A brief discussion follows). Arch, Lond—Dec. 11, 1896. 6,000 w. 30 cts.

9975. The Berlin Book of Buildings (A review of an illustrated and descriptive book of the architectural and constructional works of Berlin, issued in commemoration of the conference of the German architectural and engineering societies in the German capital). Builder—Dec. 12, 1896. 2,500 w. 30 cts.

9976. Color in the Architecture of Cities. Halsey Ricardo (Abstract of lecture given in connection with the Arts and Crafts Exhibition Society. Discusses the principle for the application of color, the value, with reference to color in Venice and other places). Builder—Dec. 12, 1896. 1,400 w. 30 cts.

9987. Fireproofing Buildings (Discusses means of making buildings already built of combustible materials, capable of resisting fire). Fire and Water—Dec. 19, 1896. 900 w. 15 cts.

10003. The Prevention of Rust in Iron and Steel Structures (Editorial showing the importance of this question and our duty to posterity). Sci Am—Dec. 26, 1896. 1,100 w. 15 cts.

10007. The Case Against the Ecole des Beaux-Arts. Ralph Adams Cram. (Read before the Boston Soc. of Arch'ts. Not an attack on the system of instruction, but an inquiry into the methods and results of this system of education, with a view to finding out if it is defective in certain directions). Am Arch—Dec. 26, 1896. 8,200 w. 15 cts.

10,044. The Ancient Town Halls of Europe. Dr. Rowand Anderson (Inaugural address to the Edinburgh Architectural Ass'n. Showing what was done by municipalities from the twelfth to the sixteenth centuries, in rearing buildings of beauty and magnificence, and encouraging art). Builder—Dec. 19, 1896. 3,500 w. 30 cts.

10,048. The Strength of Columns. J. B. W. Stokes (Brief abstract of paper read at meeting of the Glasgow and West of Scotland Technical College Scientific Soc., with list of tables giving information on this subject). Prac. Eng.—Dec. 18, 1896. 500 w. 30 cts.

10,133. A Plea for the Use of Natural Forms Revealed by the Microscope as Suggestions for Architectural Enrichment. W. H. Seth-Smith (Read before the Brit. Arch. Ass'n. Calls attention to the tendency of the human mind to weary of even beautiful forms, and points out the advantage of studying the beautiful forms revealed by the microscope, as suggestive to work in stone carving, &c. Discussion follows). Builder—Dec. 26, 1896. 5,000 w. 30 cts.

10,157. To Canterbury, Bath and Oxford. T. Raffles Davison (Architectural studies, with illustrations). Brit. Arch.—Dec. 18, 1896. 4,000 w. 30 cts.

10,166. The Temple Church. Alfred J. Glasspool (Historical and descriptive). Arch, Lond.—Dec. 25, 1896. 1,200 w. 30 cts.

10,179. Practical Masonry and Stone-Cutting. E. W. Hind (In this series of articles the artist proposes illustrating and explaining practical methods by which the stone-cutter may obtain the necessary moulds, &c., required to ascertain the correct shape and size of each piece which belongs to the more intricate problems. Part first deals with arches in circular walls; or, circle on circle simplified). Ill. Car. & Build—Dec. 25, 1896. Serial. 1st part. 1,100 w. 30 cts.

10,291. Test of the Bailey System of Fireproof Flooring (Description of construction and very successful test). Eng. News—Jan. 7, 1897. 350 w. 15 cts.

CIVIL ENGINEERING.

BRIDGES.

9695. The Mechanical Action and Resultant Effects of Motive Power at High Speeds on Bridges (Report presented to the Assn of Ry Supts of Bridges and Buildings). Can Eng—Dec. 900 w. 15 cts.

9699. Burlington Channel Swing Bridge (Illustrated description of a workable bridge under difficult conditions. The motive power is electricity). Can Eng—Dec. 1000 w. 15 cts.

9701. A Novel French Highway Bridge. From "Le Genie Civil." (General elevation and several details of a highway bridge of French design located in Paris. It carries an important street over the Orleans Ry). Eng News—Dec. 10. 450 w. 15 cts.

9821. The Distribution of the Pressure of Piers Upon Their Foundations. (Ueber die Vertheilung des Pfeilerdrückes in den Fundamenten.) Rudolf Mayer (A valuable contribution, with diagrams, to the important subject of the distribution of pressure in masonry piers). Z. Oesterr, I. u A V.—Dec. 11, '96. 200 w.

9822. The Reconstruction of the Bridge Over the Inn Between Branau and Simbach. (Der Umbau der Branau-Simbacher Innsbrücke). Leopold Petri (Consists principally of a description of the construction of the masonry piers and their pneumatic foundations. Two plates of details of the caissons and air locks). Oesterr Monat O B—Dec., '96. 5,000 w.

9826. The Kornhaus Bridge at Berne. (Die Kornhausbrücke in Bern.) H. V. Linden (Four articles containing an account of the new iron arch bridge of 112.5 metres span to be built over the Aar. Detail drawings. Schw Bauz). Oct. 17 to Nov. 7, '96. 9000 w.

9913. Stone Filled Concrete Pier (Details of method for hastening the work of construction of the Cascade Bridge of Burlington, Iowa). Eng News—Dec. 17. 500 w. 15 cts.

9917. Double Deck Highway and Railway Bridge, Rock Island, Ill. (Illustrated description of one of the most important bridge structures constructed in the United States during the past year). Eng News—Dec. 17. 5000 w. 15 cts.

9952. Large Span Railway Bridges. E. W. Young (A letter discussing the proposed long span railway suspension bridge across the Hudson River, and a short editorial reply). Engng—Dec. 11. 1500 w. 30 cts.

9973. Proposed Suspension Bridge of 200 Feet Span Over the Tegga River, near Demagiri, South Lushai Hills. H. C. Banerji (Description with drawings). Ind Engng—Nov. 14, 1896. 1200 w. 45 cts.

10103. The Mira River Bridge, Nova Scotia. M. Murphy (Brief account of bridge remarkable for the cheapness with which it was constructed). Eng News—Dec. 81, 1896. 400 w. 15 cts.

10176. The Rue de Tolbiac Bridge, Paris (A brief review of the novel and peculiar features, with interior perspective of one of the main spans). Eng Lond—Dec. 25, 1896. 900 w. 30 cts.

10285. The St. Lawrence Bridge Competition (Plans, with brief description, submitted by engineers from the United States, Canada, England and Belgium. Special features are given, with aggregate weights and cost). Eng News—Jan. 7, 1897. 4,200 w. 15 cts.

10287. The Terminals of the Brooklyn Bridge Railway (A review of past discussions regarding the facilities and an explanation of the changes made by the switching by electricity and their effect upon the solution of the difficulties). Eng News—Jan. 7, 1897. 2,200 w. 15 cts.

CANALS, RIVERS AND HARBORS.

9840. The Corner-Stone Laying of the New Harbor of Constanza (Die Grundsteinlegung im neuen Hafen von Constanza). Friedrich Bömches (Plan and description of the new docks and breakwater of which the corner-stone was laid last October, and which form part of the plan to facilitate the handling of the grain product of Western Europe to better advantage). Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Nov. 20, 1896. 2,500 w.

10027. Bombay Port Trust (A short description of the development of the property vested in the Trustees of the Port of Bombay. Gives the principal works and conveniences for shipping and traffic). Ind Engng—Nov. 21, 1896. Serial. 1st part, 900 w. 45 cts.

10100. Movable Dams on the Great Kanawha River, West Virginia (Photographs, general elevation and notes describing this work). Eng News—Dec. 31, 1896. 1,000 w. 15 cts.

10177. An Old West Country Canal (History of an old canal of England, the Grand Western Canal, constructed about a century ago). Eng, Lond—Dec. 25, 1896. 1,700 w. 30 cts.

10205. The Great Reservoir System of the Upper Mississippi. W. S. Harwood (Illustrated account of this unique enterprise, by which the water of the river is controlled in flood and drought, aiding navigation, commerce, and preventing deterioration of water used for domestic purposes and furnishing water for irrigation). Harper's Weekly—Jan. 9, 1897. 4,000 w. 15 cts.

10286. The History of the Monongahela Navigation Co. From the Pittsburg Times (The history from 1832 is reviewed, with information regarding further improvement). Eng. News—Jan. 7, 1897. 900 w. 15 cts.

HYDRAULICS.

10184. Familiar Methods for Calculating the Flow of Water Through Pipes (Abridged from an essay presented by the N. Y. delegation and read at the Master Plumbers' Annual Convention, Boston, June 27, 1888. Simple, practical rules for problems in hydraulics). San. Plumb—Jan. 1, 1897. 2,000 w. 15 cts.

IRRIGATION.

9733. The Irrigation Works of the Pecos Valley. Elwood Mead (An interesting description of the method used in this valley and the changes wrought by water). Purdue Soc of Civ Engs—1896. 1,800 w. 45 cts.

9915. The Ownership and Control of Water in the Irrigable West. Elwood Mead (Letter calling attention to features of the water laws not generally understood). Eng News—Dec. 17, 1896. 1,200 w. 15 cts.

10041. Water Development by Tunneling at Ontario, Cal. James T. Taylor (The object of this tunnel was to intercept the underflow from the mountain range known as the Sierra Madre and divert the water so developed by gravity into the present system for an increased supply of the Ontario lands. Account of work thus far). Eng News—Dec. 24, 1896. 800 w. 15 cts.

MISCELLANY.

9703. Proposed Standard Specifications for Portland Cement. William J. Donaldson (A reply to article by Mr. Lesley, which criticises the proposed specifications advanced by the writer). Eng News—Dec. 10. 5,000 w. 15 cts.

9719. Foundations. W. A. Truesdell (An embodiment of ideas and observations gathered during several years of practice). Wis Eng—Oct. 4,000 w. 45 cts.

9730. The Business Wisdom and Responsibility of the Engineer. W. F. Goodhue (A talk to young engineers on the subject named, from one whose experience and contact with men entitle him to consideration). Purdue Soc of Civ Eng —1896. 9,000 w. 45 cts.

9734. The Civil Engineer: His Work and Character. Rev. C. B. Wilcox (A talk to young engineers, showing the demand for their labor, and the qualities essential to success). Purdue Soc of Civ Eng—1896. 1,200 w. 45 cts.

9837. Concerning the Relation of Elasticity and Resistance of Pillars of Variable

Moduli of Elasticity.—Ueber die Elasticitäts und Festigkeits-Verhaltnisse von Stäben mit Verandlichen Elasticitätsmodul (A highly mathematical discussion of the subject of elasticity of compound structures, such as occur in the Melan system and elsewhere). Zeitschr d Oesterr Ing u Arch Ver—Dec. 25, 1896. 3,000 w.

9916. Standard Cement Specifications of the South Australian Government (A copy of the standard specifications for Portland cement supplied to Australia for use on its public works, under which satisfactory material has been for some time received). Eng News—Dec. 17. 1,100 w. 15 cts.

9941. Solar Work in Land Surveying. J. D. Varney (A statement of the principles involved and an exhibition of a new solar device. Illustrations). Jun Assn of Enging Soc—Nov. 5,400 w. 30 cts.

10039. The Late Gales and the Brighton Piers (Editorial comment on the injury caused by recent storms. The wrecking of Mr. Volk's electric tramway and the marine railway to Rottingdean, pleasure piers, &c.). Eng, Lond—Dec. 18, 1896. 1500 w. 30 cts.

10126. Highway Improvement in Vermont (Illustrated account of the work done by the State Highway Commission, with extract from second annual report). Munic Engng—Jan., 1897. 1800 w. 30 cts.

10284. The Manufacture of Slag Cement in France (Describes the manufacture as practiced in Vitry-le-Francois, one of the latest manufactories. From the "Nouvelles Annales da la Construction"). Eng News—Jan. 7, 1897. 700 w. 15 cts.

10288. A New Test of the Rate of Setting Cement. William S. Mac Harg (Letter presenting a simple method of testing the rate of setting of cement, apparently worthy of investigation. Also brief editorial). Eng News—Jan. 7, 1897. 1600 w. 15 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

9650.—The Paramount Control of the Commerce of the World. Edward Atkinson (Showing that the resources of the United States and the potential demand for them are sufficient to make her foremost in commerce whenever the questions of money, banking, and taxation shall be settled in accordance with economic law). Eng Mag—Jan. 7,800 w. 30 cts.

9651.—Evidences of Health Throughout the Industrial World. L. G. Powers (A statistical paper establishing a favorable contrast between the industry and commerce of 1896 and those of previous years). Eng Mag—Jan. 3800 w. 30 cts.

9728. The Commercial War Between Germany and England. B. H. Thwaite (The writer considers the secret of Germany's great industrial progress to be polytechnic education and philosophic training. He cites examples in proof of his opinions and recommends England to rely upon scientifically controlled industrial processes). Nineteenth Cent—Dec., 2,500 w. 45 cts.

9908.—The Cycle Industry in the United States. From the London Times (An interesting article showing the surprising development of this industry). Cons Repts—Dec. 2,000 w. 45 cts.

9919.—Future of American Manufacturers (Abstract of address by Mr. Theodore C. Search, Pres. of the National Assn. of Manufacturers. The magnitude of our industrial interests). Mfrs. Rec—Dec. 18. 2,400 w. 15 cts.

10000. The Department Store. Samuel Hopkins Adams (The first of a series of articles on "The Conduct of Great Businesses," showing the vital points of American business life. Dealing with the part men's brains play in large business enterprises. Illustrations). Scribner's Mag —Jan., 1897. 1,800 w. 30 cts.

10015. Details of Our Foreign Trade (The satisfactory condition of our export trade. Since 1895 our monthly exports have exceeded imports and the balance of trade been in our favor). Bradstreet's—Dec. 26, 1896. 1,000 w. 15 cts.

10018. Foreign Competition with British Trade (W. S. Harriss-Gastrell in his report to the Foreign Office. The necessity of effort to prevent any further loss of trade, with suggestions). Bd of Tr Jour—Dec., 1896. 2,500 w. 30 cts.

10019. Tariff Changes and Customs Regulations (Belgium, Germany, France, Italy, United States, Guatemala, Brazil, British India, Sierra Leone and Western Australia). Bd of Tr Jour—Dec., 1896. 1,800 w. 30 cts.

10098. Our Own Ships for Our Foreign Trade Essential to Prosperity. William W. Bates (Discusses the advantage of using shipping of our own and the disadvantage and loss of employing foreign shipping). Arena—Jan., 1897. 4,000 w. 80 cts.

10021. Business Failures in 1896 (Tabulated summary of the business embarrassments in the United States, Canada and Newfoundland for ten years, with assets and liabilities; also tabulated statement of mercantile failures for seven years, with remarks). Bradstreet's—Jan. 2, 1897. 800 w. 15 cts.

10231. Foreign Trade of the United States. Worthington C. Ford (Calling attention to some notable characteristics that are concealed from view during seasons of prosperity). Tradesman—Jan. 1, 1897. 3,300 w. 15 cts.

10232. Future Trade with South America. C. D. Mitchell (The practical work undertaken by the National Association of Manufacturers). Tradesman—Jan. 1, 1897. 1,700 w. 15 cts.

10233. Important Features in Southern Export Trade Which Manufacturers Cannot Overlook. Henry S. Fleming (Calls attention to the introduction of goods, the class of goods required, measurements, packing and credits). Tradesman—Jan. 1, 1897. 1,200 w. 15 cts.

10234. Export Trade in the South. Charles Earl Currie (In regard to the selection of foreign territory in which to introduce Southern goods, transportation facilities, &c). Tradesman—Jan. 1, 1897. 4,000 w. 15 cts.

10235. Our South American Trade. Edwin Lefevre (The necessity for better acquaintance with the requirements of the sister republics). Tradesman—Jan. 1, 1897. 4,000 w. 15 cts.

10243. How to Promote Industrial Growth (A series of opinions by officers of the largest commercial organizations in the South). Tradesman—Jan. 1, 1897. 1,800 w. 15 cts.

10270. An English View of German Trade Rivalry (The effect of the enforced label "Made in Germany" is shown to have been a benefit. The statements made in book by Ernest Edwin Williams are cited and various industries discussed). Cons Repts—Dec., 1896. 2,000 w. 45 cts.

CURRENCY AND FINANCE.

9652. Public Credit as Related to Engineering Enterprise. Gustav Lindenthal (Reviewing the great engineering projects that are awaiting for their realization only a renewal of confidence and a consequent availability of capital). Eng Mag—Jan. 4,200 w. 30 cts.

9682. The Monetary Issue in the United States (Explains the main issue in the late Presidential campaign as presented by Mr. Horace White). Bankers' Mag, Lond—Dec. 1,500 w. 30 cts.

9727. Money and Investments. Emma Cons (The article is devoted largely to the question at stake in the last Presidential campaign in the U. S., and to criticism of management of finances in the U. S. Other issues of special interest to England are briefly considered). Contemporary Rev—Dec. 5,500 w. 45 cts.

10014. Carlisle on Currency and Revenue Legislation (His argument in the last annual report as to the need of legislation to retire the greenbacks). Bradstreet's—Dec. 26, 1897. 1,800 w. 15 cts.

10152. Financial Review of the Year (The financial events for the year 1896 are briefly traced). Eng & Min Jour—Jan. 2, 1897. 900 w. 15 cts.

10206. Some Practical Suggestions from Students of Finance (A symposium of opinions of representative economists identified with leading American universities). Rev of Revs—Jan., 1897. 10,500 w. 30 cts.

GOVERNMENTAL CONTROL.

9788. The Working of Arbitration. H. W. Wilson (A collection of instances which the writer claims give a fair idea of the working of arbitration. The dangers and defects are shown). Fortnightly Rev—Dec. 5,000 w. 45 cts.

9918. The Nicaragua Canal. Joseph Nimmo, Jr (An appeal for a thorough governmental investigation of its commercial and military aspects). Mfrs Rec—Dec. 18. 2,800 w. 15 cts.

LABOR.

9833. The Industrial Colony of the Salgo-Tarjan Coal Mining Company (Die Arbeiter-Colonien der Sàlgo-Tarjàner Kohlenbergbau - Actien - Gesellschaft). Alois Meissner (An interesting account of the co-operative association at Salgo-Tarjan, with plans of the property and houses). Plate. Oesterr. Monatschr. f. d. Oeff. Bau—Dec., 1896. 2,000 w.

9909. Rates of Wages Paid Under Public and Private Contract. Ethelbert Stewart (Tables giving the results of investigations in the cities of Baltimore, Boston, New York and Philadelphia as to wages paid for the same occupations and similar work). Bul of Dept of Labor—Nov. 5,000 w. 45 cts.

9958. A Curious Strike (Editoral on the strike at the works of Messrs. Gwynne & Co., Brook-street, Holborn). Eng Lond—Dec. 11. 1,100 w. 30 cts.

10097. Strikes as a Factor in Progress. M. E. J. Kelley (Showing how from the workman's point of view all strikes are beneficial to the working people, whether they succeed or not). N Am Rev—Jan., 1897. 2,800 w. 45 cts.

10099. The Plea of Labor from the Standpoint of a Russian Peasant. Ernest Howard Crosby (Abstract of and comment on a book entitled "Work, According to the Bible," by Timothy Michaelovitch Bondareff). Arena—Jan., 1897. 4,800 w. 30 cts.

10106. A Threatened Strike on the London & North Western Railway. W. M. Acworth (An account of an escape from what looked like a serious crisis on this railway). R R Gaz—Jan. 1, 1897. 2,000 w. 15 cts.

10138. Strike at the Plymouth Gas Works (An account of the trouble and its settlement). Jour of Gas Lgt—Dec. 22, 1896. 2,000 w. 30 cts.

10165. Employers' Liability and Compensation to Workmen (Suggestions offered by a correspondent of the London Times in regard to the present law of England on this subject). Arch Lond—Dec. 25, 1896. 1,200 w. 30 cts.

10214. An American System of Labor Pensions and Insurance. Paul Monroe (The various methods for industrial amelioration are discussed, and the needs as met in different countries and as required by different nationalities. The system in operation in the extensive manufacturing enterprises of Alfred Dolge & Son at Dolgeville, N. Y., is given). Am Jour of Soc—Jan., 1897. 5,000 w. 45 cts.

10215. Eccentric Official Statistics. H. L. Bliss (A criticism of statistics furnished by the government, especially in regard to labor and trade). Am Jour of Soc—Jan., 1897. 5,400 w. 45 cts.

10225. Labor Organizations Made a Necessity by Actions of Managers of Industrial Establishments. B. R. Lacy (Claiming that the treatment of workmen causes labor organizations, and that sufficient work cannot be provided until idle money is invested). Tradesman—Jan. 1, 1897. 1,400 w. 15 cts.

10271. Evolution of English Trade-Unionism (Extracts from a paper on "Primitive Democracy in British Trade-Unionism," by Sidney and Beatrice Webb, of London, published in the Political Science Quarterly). Gunton's Mag—Jan., 1897. 2,200 w. 30 cts.

MISCELLANY.

9663. Abuses of Our Patent System by Trusts, Corporations, Lawyers and Experts (The first of a series of articles aiming to show how the powers of "Trusts" are used for the purpose of strangling legitimate and worthy enterprises, and to illustrate the manner in which the patent laws are made to serve infamous purposes). Elec—Dec. 9. Serial, 1st part. 1,300 w. 15 cts.

9726. The Unemployed. W. R. Bousfield (Comment and criticism on the reports of select committees on distress from want of employment. The question of the unemployed is discussed by the critic from a classification made by him). Contemporary Rev—Dec. 8,000 w. 45 cts.

10216. The Present Status of Sociology in Germany. Dr. O. Thon (Part first shows reasons which partly account for its rejection as a science and explains the form it has assumed in Germany. A study of the subject is commenced). Am Jour of Soc—Jan., 1897. Serial, 1st part. 8,000 w. 45 cts.

10217. Principles of Public Charity and of Private Philanthropy in Germany. Dr. E. Muensterberg (A report on the system of poor relief in use in Hamburg). Am Jour of Soc—Jan., 1897. Serial, 1st part. 5,000 w. 45 cts.

10272. Failure of the Nail Combine (History of the combination). Gunton's Mag—Jan., 1897. 2,200 w. 30 cts.

10273. Natural Causes of Agricultural Depression. Jerome Dowd (Showing why agriculture in many localities is unprofitable. That the outlook is not necessarily gloomy). Gunton's Mag—Jan., 1897. 1,200 w. 30 cts.

10292. Values, Positive and Relative. W. G. Langworthy Taylor (A scientific study. The conception of value pointed out is the result of a desire to contribute to a solution of the question of deferred payments). An Am Acad—Jan., 1897. 10,800 w. $1.

10295. Official Statistics of India-Rubber and Gutta-Percha (Statistics for the export and import trade of the year ending June 30, 1896). Ind Rub Wld—Jan. 10, 1897. Tables. 35 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY AND METALLURGY.

9688. Electrolytic Precipitation of Gold from Cyanide Solutions. Stuart Croasdale (Experiments were made and reasons given for the method decided upon, which was electrolytic precipitation, using amalgamated zinc plates for the positive electrodes and sheet lead for the negative electrodes). Eng & Min Jour—Dec. 12, 1896 750 w. 15 cts.

9805. The Application of Porous Carbon Cells in Electrolysis. (Die Verwendung Poröser Kohlecylinder bei Elektrolytischer Versuchen). Walther Lob. (Porous Cells of Carbon were used with solutions to be decomposed placed within and without. The carbon was used either as cathode or merely as a separating conductor. In the former case the decomposition takes place both within and without the carbon cell). Zeitschrift für Elektrochemie—Nov. 5, 1896. 2000 w.

9806. The Generation of Electricity by Chemical Action. (Elektricitätserregung auf Chemischem Wege). Ernst Andreas (A description of an improved gas battery in which the elements are composed of net-works of platinum wire between sheets of blotting paper, excited by various gases. It is suggested that this may be made available for the generation of electricity as a by-product in some chemical industries, such for example as the manufacture of sulphuric acid). Zeitschrift für Elektrochemie—Nov. 5, 1896. 1200 w.

9807. Electric Furnaces for the Separation and Refining of Metals. (Die Elektrischen öfen zur Metallgewinnung und Metallraffination). Dr. W. Borchers (The first of a series of articles upon electric furnaces. This installment contains a classification and a brief description of some of the earlier types). Zeitschrift für Elektrochemie—Nov. 5, 1896. Ill. 2000 w.

9809. The Meaning of Arrhenius' Theory of Ion Groups in Analytical Chemistry. (Die Bedeutung der Arrhenius' schen Theorie der Ionenspaltung fur die Analytische Chemie). F. W. Kuster (Showing the application of Arrhenius' theory to analysis by passing an electric current through the solution and observing the conductivity and polarity). Zeitscrift für Elektrochemie—Dec. 5, 1896. 2500 w.

9810. Concerning the Influence of Intermediate Conductors. (Ueber das Verhalten von Mittelleitern). Dr. Hugo Kauffman (A mathematical investigation of the action of isolated conductor placed in a solution undergoing electrolysis. This bears upon the same subject as No. 9805, in which a porous carbon cell plays such a part). Zeitschrift für Elektrochemie—Dec. 5, 1896. 1500 w.

9811. The Use of Electrically Produced Chloride of Lime in Cotton and Linen Bleaching. (Praktische Ergebnisse bei Anwendung van auf Elektrolytischem Wege Hergestellten Chlorkalk in der Baumwoll und Leinenbleicherei). (This article shows that chloride of lime produced by the electrical decomposition of common salt possesses especial advantages for bleaching purposes, both for superior results and greater economy, and pronounces its introduction as a great step forward.) Elektrochemische Zeitschrift—Nov., 1896. 1500 w.

9812. Concerning Accumulators with Gas Relief. (Ueber die Akkumulatoren mit Entgasungseinrichtung). Jos. Zacharias (This is a description of improvements in electrical accumulators in which opportunity is given for the free escape of the gases which otherwise cause the rapid deterioration of the elements. The use of organic materials for the absorption of the gases is also suggested). Elektrochemische Zeitschrift—Nov., 1896. 3000 w.

9813. A new Method of Separating Metals by Means of Soluble Anodes. (Eine Neue Trennung von Metallen Mittels Löslicher). R. Pauli. (An extension to other metals of the principle exhibited by the deposition of copper upon iron from a solution of cupric sulphate, or of iron upon zinc.) Elektrochemische Zeitschrift—Nov., 1896. 1,000 w.

9843. Progress in the Electro-Chemical Industry. (Fortch schritte auf dem Gebiete der Elektrochemischen Industrie). Dr. Hugo Ritter v. Perger. (An address delivered before the Society of Austrian Engineers and Architects, reviewing the applications of electricity to industrial chemistry during the last few years. Two articles. Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Dec. 11 and 18, 1896. 12,000 w.

9981. On the Manufacture of Alkali and Bleach by Chemical and Electrolytical Methods. Bertram Blount (Read before the Northern Soc. of Elec. Engs. A comparison and a summing up of the weak and strong points of the two methods). Elect'n—Dec. 11, 1896. 5,500 w. 30 cts.

10178. Electricity in Relation to the Chemical and Metallurgical Industries. John B. C. Kershaw (This series of articles' proposes to notice the electro-chemical and electro-metallurgical processes now at work on an industrial scale, so far as information concerning them is obtainable, thus providing a general review of these industries at the end of 1896). Elect'n—Dec. 25, 1896. Serial, 1st part. 1,000 w. 30 cts.

10208. On the Formation of Lead Sulphate in Alternating Current Electrolysis. with Lead Electrodes. Samuel Sheldon and Marcus B. Waterman (Results of experiments to determine whether electrolytic condensers, formed with lead electrodes, might not have a high efficiency, acting much in the same manner as the lead plates of a storage battery). Phys Rev—Jan.-Feb., 1897. 1,200 w. 50 cts.

10211. On the Hydrolysis of Ferric Chloride. H. M. Goodwin (Results of some experiments on the changes which take place in a neutral ferric chloride solution when suddenly diluted. Based on the electric conductivity). Tech Quar—Dec., 1896. 3,600 w. 75 cts.

LIGHTING.

9677. Two Interesting Small Electric Lighting Plants. C. G. Robbins (Describes two plants containing many features of interest. The plant of F. & R. Lazarus, at Columbus, O., and the plant known as No. 1 plant of the Block Lighting and Power Co., located in New York City. Illustrated). Power—Dec. 3,800 w. 15 cts.

9714. Portable Electric Plant for Show Lighting (Describes the electrical equipment and illustrates the plant used by "Buffalo Bill's Wild West"). W Elec—Dec. 12. 1,000 w. 15 cts.

9769. The Electric Arc for Lantern Projection. E. P. Hopkins (The main difficulties with other forms of illumination are briefly presented, and the article describes in detail the arc light as applied to this use, pronouncing it the most perfect and ideal illuminant for the work). Elec Eng—Dec. 16. Serial. 1st part. 1,200 w. 15 cts.

9846. The Lighting of Theatres by the Fredereau Diffusers (L'Eclairage des Theatres et les Globes Diffuseurs Fredereau). G. Mercier (An illustrated description of the installations of the Fredereau Diffusers at the Casino de Cabourg and at the Monte Carlo Theatre). La Révue Technique—Nov. 10, 1896. 1,000 w.

9934. Principles of Electrical Distribution. Francis B. Crocker (The subject is studied in connection with electric lighting, although it applies to all branches of electrical transmission and distribution. Part first discusses materials for electrical conductors, electrical resistance and the standard conductivity of copper). Elec Wld—Dec. 19. Serial. 1st Part. 2,000 w. 15 cts.

9940. Armorite Interior Conduit (Illustrated description of a new electrical specialty). W Elec—Dec. 19. 2,000 w. 15 cts.

9997. How to Make a Constant Potential Arc Lamp. Cecil P. Poole (Sketches and instructions that will enable any mechanic to make a reliable arc lamp, if he has a fair knowledge of electrical apparatus). Am Elect'n—Dec., 1896. 1,700 w. 15 cts.

10006. Hand Feed Electric Lamp for Lanterns. George M. Hopkins (Illustrated description). Sci Am—Dec. 26, 1896. 800 w. 15 cts.

10034. Chester Electricity Works. (Illustrated detailed description). Elec Eng, Lond—Dec. 18, 1896. 5500 w. 30 cts.

10081. Electric Lighting of the Royal Poinciana Hotel at Palm Beach, Florida (Illustrated description). Elec Eng—Dec. 30, 1896. 800 w. 15 cts.

10118. Good and Bad Steam Piping for Electric Lighting Engines in Office Buildings (Deals with the steam piping of an office building where the head room is restricted and the practice of large central stations is impossible. Discusses methods and dangers). Eng Rec—Jan. 2, 1897. 1600 w. 15 cts.

10163. Malta Electricity Supply (A detailed description of the works which have been undertaken by the Government of Malta). Elec Eng, Lond—Dec. 25, 1896. 2500 w. 30 cts.

10172. Electrical Work in South America (Brief account of progress, especially in Buenos Ayres). Elec Rec Lond—Dec. 25, 1896. 900 w. 30 cts.

10187. Oriental Electric Lighting. Lester Betts (Part first deals with the selection of the most suitable estimate and specification submitted. The series seems to aim to give information that will insure the selection of good material and the installation of a successful plant). Ind and East Eng—Dec. 5, 1896. Serial first part 1500 w. 45 cts.

10249. The City Council Electric Light Plant in Melbourne, Australia. Frank W. N. King (Illustrated description of the works of the Melbourne City Council). Elec Wld—Jan. 2, 1897. 1600 w. 15 cts.

10274. Decorative Lighting. E. J. Jenness (Read before the Chicago Elec Assn Dec. 16, 1896. Considers lighting effects as applied to scenic theatres and decorative work as applied to tower lighting for advertising and other purposes). W Elec —Jan. 9, 1897. 2,300 w. 15 cts.

POWER.

9655. The Wonderful Expansion in the Use of Electric Power. Ill. Louis Bell (Tracing the development of electrical applications to the problems of transportation and transmission). Eng Mag—Jan. 3,700 w. 30 cts.

9690. External Regulation of Alternating-Current Motors. Albert G. Davis (Describes devices for the speed regulation of alternating-current motors in which the speed of the motor is controlled by changing the character of the current delivered). Elec Wld—Dec. 12. 1,700 w. 15 cts.

9691. Shunt Motors for Railway Work. William Baxter, Jr. (The objections and advantages are given and the subject discussed, showing that shunt-wound motors arranged so that the fields may be commuted have many desirable features and may possibly be made as reliable as series motors). Elec Wld—Dec. 12. 2,500 w. 15 cts.

9721. Comparative Commercial Qualities of Alternating Current Motors. W. H. Williams and J. H. Perkins (Synopsis of thesis submitted for the degree of Bachelor of Science in Electrical Engineering. Describes a series of tests of 5 H. P. alternating current motors of various makes. A table of comparative qualities and efficiency curves of several of the latest type direct current motors are given). Wis Eng —Oct. 1,300 w. 45 cts.

9723. Electric Motors in Factories. C. M. Conradson (The writer is a believer in direct connected motors wherever possible. Tests were made by the writer and conclusions are given). Wis Eng—Oct. 2,700 w. 45 cts.

9770. A New Method of Speed Control for Electric Motors. W. A. Anthony (Views of the writer on this subject. Describes a method which he believes will be found valuable in most cases where variable speed is required). Elec Eng—Dec. 16. 800 w. 15 cts.

9791. Some Problems in Electric Elevator Work. H. Cochrane (The writer reviews some of the details of practical construction, showing that the application of electricity to elevator service involves a great many engineering problems. Illustrated). Sib Jour of Engng—Dec. 5,000 w. 30 cts.

9800. Motor and Magnetic Brakes for Trolleys. (Motorische und Magnetische Bahnbremsen). Max Schieman (An examination of the use of reverse current braking and of the use of electro-magnetic brakes acting upon friction disks attached to the axles. 5 illustrations). Deutsche Zietschrift für Elektrotechnik—Oct. 15, 1896. 2,500 w.

9801. Electrical Plants for Small Towns. (Elektricitätswerke für Kleine Städte) (A warning to small towns against the hasty adoption of electric lighting, and a review of the conditions under which such installations are likely to be successful). Deutsche Zeitscrift für Elektrotechnik—Oct. 15, 1896. 700 w.

9906. Electrical Devices for Changing the Speed of Shunt Motors. William Baxter, Jr (Discusses the methods for changing the speed of shunt motors). Am Mach—Dec. 17. 1,400 w. 15 cts.

9939. Smith's Electro-Magnetic Elevator (Illustrated description of an elevator possessing features of interest. It makes use of the principle of the solenoid or coil and plunger to utilize the power to move the car). W Elec—Dec. 19. 3,700 w. 15 cts.

9980. A 640 Horse-Power Hutin-Leblanc Alternater with Stationary Armature. F. Guilbert (Abstract of an article in L'Industrie Electrique of Nov. 10. Illustrated description). Elect'n—Dec. 11, 1896. 1300 w. 30 cts.

9988. The Bridge Mill Power Plant of the Pawtucket, R. I. Electric Co. (Illustrated description). Elec Eng—Dec. 23, 1896. 3000 w. 15 cts.

9990. The Churchward Equalizer System of Distribution. A. Churchward (Describes a system which has been in use in a central station in New York City for three years without a breakdown in the balance of the two circuits. Illustrated). Elec Eng—Dec. 23, 1896. 800 w. 15 cts.

10017. The Relation of Magnetic Flux to Output in Dynamos. P. M. Heldt (An attempt is made to deduce an algebraic relation between the useful magnetic flux and the output of a dynamo, and to evaluate the constant occurring in this equation from the data of actual machines). Elec Wld—Dec. 26, 1896. 1,100 w. 15 cts.

10093. The Latest Improvements in Electric Elevators (Illustrated description of high grade electric passenger-elevator used in fireproof buildings). Sci Am—Jan. 2, 1897. 1,100 w. 15 cts.

10222. What Has Been Accomplished in the Long-Distance Transmission of Power by Electricity (A summary of what has been accomplished in this line, with illustrations of the different plants, giving an idea of their character and magnitude). Am Mach—Jan. 7, 1897. 2,000 w. 15 cts.

10248. Fuel Energy Into Electrical Energy. Elihu Thomson (Reviews the various types of apparatus for effecting the conversion, and concludes that there is not for the present any danger of boilers and engines passing out of use). Elec Wld—Jan 2, 1897. 1,500 w. 15 cts.

10250. Parallel Operation of Alternators. Charles Proteus Steinmetz (Advises the operation in parallel wherever feasible and showing that if equality of frequency and constancy of frequency have been provided for, they will run satisfactorily, and if they cannot be fulfilled, parallel operation is impracticable). Elec Wld—Jan. 2, 1897. 1,400 w. 15 cts.

10254. The High-Tension Accumulator of the Jefferson Physical Laboratory of Harvard University. John Trowbridge (Constructed for the study of the discharges of electricity through gases. Description and account of satisfactory work). Elec Wld—Jan. 2, 1897. 1,300 w. 15 cts.

10257. Alternating Current Machinery. Edwin G. Houston and A. E. Kennelly (It is proposed in this series of articles to discuss the development, laws and properties of alternating currents and the methods of their practical application to the transmission of power. Part first is introductory). Elec Wld—Jan. 2, 1897. 1,000 w. 15 cts.

TELEGRAPHY AND TELEPHONY.

9704. The Basis of Telephone Charges. Fred De Land (A table is given showing the possible combinations as based on the number of subscribers, and how expenses increase). Elec Engng—Dec. 900 w. 15 cts.

9706. European Telephone Statistics for the Year 1894. Franz J. Dommerque (Table calculated from data furnished by the "Journal Telegraphique"). Elec Engng—Dec. 350 w. 15 cts.

9715. Proposed Consolidation of the Commercial Cable and Postal Telegraph-Cable Companies (An outline of the history of the two companies, and statement of the conditions on which a consolidation is proposed) W Elec—Dec. 12. 1,000 w. 15 cts.

9771. The New Cable to Hayti (Map showing course of the new cable, with connections. Also brief account of rates and matters of interest). Elec Eng—Dec. 16. 600 w. 15 cts.

9907. Through Telephone Eyes (Views on European methods as given by general manager Angus S. Hibbard, of the Chicago Telephone Co.) Elec Rev—Dec. 16. 1,300 w. 15 cts.

9970. Postal Telegraphs—New Form of Morning Test Switch Tablet (Illustrated description of arrangement). Elec, Lond—Dec. 4, 1,100 w. 30 cts.

10011. The Making and Laying of an Atlantic Cable. Henry Muir (Illustrated description of the work of constructing, laying and repairing cables). McClure's Mag—Jan., 1896. 5,000 w. 15 cts.

10032. Localizing Faults in Submarine Cables. Herbert E. Cann (Tables showing different strengths of currents, comparison of results, testing through an artificial cable, and through wire resistance, are given and explained, and conclusions from a series of experiments are given). Elec Rev, Lond—Dec. 18, 1896. 1,800 w. 30 cts.

10082. Military Telegraph Line from Bisbee to San Bernardino, Arizona. W. A. Glassford (An account of the erection of this line, the difficulties met and the purpose which these lines serve). Elec Eng—Dec. 30, 1896. 2,000 w. 15 cts.

10085. Telephoning and Telegraphing with a Kite Wire. William A. Eddy (An account of an interesting and successful experiment). Elec Rev—Dec. 30, 1896. 550 w. 15 cts.

10111. The Edison Phonoplex (Illustrated description with diagram of the connections for a terminal office). R R Gaz—Jan. 1, 1897. 1,200 w. 15 cts.

10247. Submarine Telegraphy. From La Nature (The new cable from Brest to New York. Also some of the difficulties in transatlantic telegraphing Sci Am Sup—Jan. 9, 1897. 1,400 w. 15 cts.

10255. Progress in American Telegraphy. F. W. Jones (Historical review). Elec Wld—Jan. 2, 1897. 2,500 w. 15 cts.

10256. The interests of the Public in the Telephone Situation. F. W. Dunbar (History of the telephone development and of the contract that divided the interests of telephony and telegraphy is given in part first, with statement of the requirements of the combined system). Elec Wld—Jan. 2, 1897. 2,300 w. 15 cts.

10269. Auxiliary Telegraphy. Dr. I. Kitsee (Illustrates and describes a device for overcoming the difficulty in transmitting messages from and to intervening stations while the line is in use at the terminal offices). Jour Fr Inst—Jan., 1897. 1,800 w. 45 cts.

10275. The Persian Gulf Cable of 1864. F. C. Webb (A sketch of the laying of the Persian Gulf Cable of 1864). W Elec—Jan. 9, 1897. Serial. First part. 1,900 w. 15 cts.

10294. Machinery for Cable Making (Illustrated description of sheathing machine, with reference to other machines used in the manufacture of submarine cables). Ind Rub Wld—Jan. 10, 1897. 700 w. 35 cts.

MISCELLANY.

9673. Electrical Speed Indicator (Describes and illustrates a revolution indicator, based upon an entirely new principle. One of the effects of the apparatus in marine work is to enable the two engines of a twin-screw ship to be kept at the same speed). Am Mach—Dec. 10. 600 w. 15 cts.

9678. A Few Points on the Care of Electrical Machinery. William Baxter, Jr. (Deals especially with the adjustment and care of brushes). Power—Dec. 4,800 w. 15 cts.

9705. The Manufacture of Wire. Frederic A. C. Perrine (The general types of insulators are described which are regularly employed for protecting wires, and the protection where necessary to prevent injurious mechanical and chemical action). Elec Engng—Dec. 7,500 w. 15 cts.

9781. The Measurement of Temperature: An Application of the Measurement of Resistance. G. M. Clark (The writer proposes to give an outline of the elements of the subject of thermometry, dealing rather with principles than details. Subsequently he will deal with the measurement of resistance, treating the subject in detail). Elec'n—Dec. 4. Serial. First part. 3,000 w. 30 cts.

9782. A Residual Photo-Electric Effect of Cathode Rays. J. Elster and H. Geitel, in Weid Ann (Describes in detail experiments and results). Elect'n—Dec. 4, 1896. 2,800 w. 30 cts.

9802. Wilhelm Hittorf (A biographical notice of Dr. Hittorf and a review of his career, upon the fiftieth anniversary of his reception of his doctor's degree. Portrait). Zeitscrift für Elektrochemie—Oct. 20, 1896. 1,000 w.

9803. A New Method for Determining Capacity for polarization. (Eine Neue Method für die Bestimmung der Polarisations Kapazität). C. M. Gordon (A paper before the Institut für Elektrochemie of Gottingen, describing a method for determining polarizing capacity by means of an induction coil and a varying liquid resistance, in connection with a Wheatstone bridge). Zeitschrift für Elektrochemie—Oct. 20, 1896. 1,200 w.

9804. Thermic Electrolytic Chains. (Ueber Elektrolytsche Thermoketten). William Duane (A contribution to the transactions of the Royal Prussian Academy of Sciences of Berlin. This is an investigation into the production of electrolytic action by a series of solutions of different temperatures). Zeitschrift für Elektrochemie—Oct. 20, 1896. 1,200 w.

9814. A Fragmentary Discussion of the So-called Electric Current. (Ein Diskontinuierliches Bild des Sogen. Elektrischen Leitungsstroms). Dr. Ludwig Silberstein (A mathematical discussion of some of the features of Maxwell's and Hertz's theories). Elektrochemisches Zeitschrift—Dec., 1896. 4,500 w.

9815. The Gulcher Accumulator. Die Gülcher - Akkumulatoren (Gulcher's improved storage battery plate is composed of a grating of leaden wires used as a warp, with a woof of fine strands of spun glass, the whole being charged with a paste of white lead). Elektrochemische Zeitschrift—Dec., 1896. Illustrated. 500 w.

9816. Novelties in Electrodes. (Neuerungen an Elektroden). Dr. H. Weyer (Two articles containing a general review of improvements in all kinds of electrodes, with references to German and English patents). Elektrochemische Zeitschrift—Nov. and Dec., 1896. Both articles 5,000 w.

9817. Concerning Lightning Rods. (Zur Blitzableiterfrage). Prof. A. Weiler (A suggestion that effective protection against lightning may be obtained by four metallic conductors running from a common point on the roof to the ground down the four corners. This is based on the fact that an electroscope surrounded by four such wires shows no indication even of strong sparks). Elektrotechnische Rundschau—Nov. 1, '96. 200 w.

9818. The Therapeutic Effect of Electrical Currents of High Frequency. (Die Therapeutischen Wirkungen Elekthischer Ströme von Honer Wechselzahl) (An account of a repetition by Dr. Krebs of d'Arsonval's experiments. Beneficial results were obtained in cases of diabetes). Elektrotechnische Rundschau—Dec. 1, '96. 3500 w.

9819. The Cupric Oxide Element. (Das Kupferoxydelement). P. Geibel (An account of the so-called "Cupron-Element" battery and of the use of cupric oxide in accumulator cells). Elektrotechnische Rundschau—Dec. 1, '96. 2000 w.

9933. Physiological Effects of the Rontgen Tube. W. M. Stine (The writer thinks they are the result of stimulation and gives reasons for the opinion). Elec Wld —Dec. 19. 900 w. 15 cts.

9972. Installation Testing. V. Zingler (The object of these notes is to provide a methodical way of testing for and tracing out faults, earths, or short circuits; also to give probable causes of same, and to suggest precautions to be taken to guard against their occurrence). Elec Rev, Lond —Dec. 11, 1896. Serial. First Part. 1,600 w. 30 cts.

9982. Dr. Jacques's Cell (Editorial criticism of article entitled "Electricity Direct from Coal," by Dr. William W. Jacques, published in Harper's Magazine for Dec., 1896). Elect'n—Dec. 11, 1896. 1,100 w. 30 cts.

9983. On the Magnetic Permeability of Liquid Oxygen and Liquid Air. J. A. Fleming and James Dewar (Read before the Royal Soc. Describes investigations). Elect'n—Dec. 11, 1896. 3,500 w. 30 cts.

9989. Are Central Stations Doomed? "Engineer" (The writer does not think central stations are doomed, but thinks the prevailing methods of stock manipulation are). Elec Eng—Dec. 23, 1896. 800 w. 15 cts.

9992. Electricity at the College of Physicians and Surgeons (Illustrated detailed description of the extensive applications of electricity in this branch of Columbia University). Am Elect'n—Dec., 1896. 1,000 w. 15 cts.

9995. Magnetic Hysteresis. Ernest J. Berg (Explains the term and discusses the causes and effects). Am Elect'n—Dec., 1896. 1,200 w. 15 cts.

9996. A Method for Measuring Resistance. H. Beinhorn (Describes a method depending upon the value of the current becoming a maximum or minimum when the resistance is changed according to a certain law). Am Elect'n—Dec., 1896. 900 w. 15 cts.

10016. Electricity in the Weather Bureau (Illustrated description of interesting features of the electrical instruments in use in the U. S. Weather Bureau in the Manhattan Life Building in New York). Elec Wld—Dec. 26, 1896. 1,800 w. 15 cts.

10145. The Theory of the Wiring Table. Thomas G. Grier (Explains method of getting at once the result in the commercial size of wire from use of table). W Elec—Jan. 2, 1897. 1,600 w. 15 cts.

10171. Communication Between Coast and Lightships (Editorial comment on the failure in the attempts to establish electrical communication). Elec Rev, Lond—Dec. 25, 1896. 2,500 w. 30 cts.

10173. The Validity of the Use of Sine Curves in Alternating Current Problems. W. G. Rhodes (Justification of the use of sine functions in the calculation of alternating current problems). Elec Rev. Lond —Dec. 25, 1896. 1,100 w. 30 cts.

10209. Polarization and Internal Resistance of a Galvanic Cell. B. E. Moore and H. V. Carpenter (Experiment, made with the object to measure the electromotive force and its changes upon closed and open circuit between the zinc and main carbons, to get the electromotive force between the zinc and special carbon at intervals, and also to obtain the electromotive force of the carbon series during the progress of the experiment, with tabulated results.) Phys Rev—Jan.-Feb., 1897. 2,000 w. 50 cts.

10210. An Apparatus for Illustrating Phase-Differences. Louis Derr (Describes an apparatus devised by the writer for showing phase-relations on a scale suited to lecture-room illustration, its operation depending on the principle that when an electric current is sent through a wire lying perpendicularly across a magnetic field, a force is developed which urges the wire at right angles to both the direction of the field and the current. Illustration). Tech Quar—Dec., 1896. 800 w. 75 cts.

10239. Southern Electrical Progress as Evidenced by the Work Performed During the Past Year. F. W. Willcox (Review of all branches of electrical work for 1896). Tradesman—Jan. 1, 1897. 4,500 w. 15 cts.

10251. On the Prospective Development of Ether Theories. Reginald A. Fessenden (Mathematical development of theories, with discussion of defects). Elec Wld—Jan 2, 1897. 1700 w. 15 cts.

10252. The Heating of Magnet Coils. Henry S. Carhart (Investigations and formula). Elec Wld—Jan. 2, 1897. 1000 w. 15 cts.

10253. Theories of the Jacques Cell. C. J. Reed (An instructive study of the possibilities of the cell). Elec Wld—Jan. 2, 1897. 3300 w. 15 cts.

10268. Observations on Magnetized Watches. William T. Lewis (Gives illustrated description of a demagnetizer being constructed by the writer; also explains the usual method of detecting magnetism in a watch and of overcoming it). Jour Fr Inst—Jan., 1897. 1500 w. 45 cts.

10276. Electrical Progress in 1896. Charles G. Armstrong, in the Chicago Record (Review of progress in electrical interests, showing substantial improvements and healthy growth). W Elec—Jan. 9, 1897. 2300 w. 15 cts.

10277. Future Electrical Development (An interview with Prof. Amos E. Dolbear, in which he mentions a few of the things which he considers may transform business methods and habits of society). W Elec—Jan. 9, 1897. 2,000 w. 15 cts.

MARINE ENGINEERING.

NAVAL AFFAIRS.

9684. Turret of the Battleship Massachusetts Under Fire. (Photographic reproductions, with description of an experimental test of turret, similar to the one named, under such conditions as will obtain in an actual sea fight). Sci Am—Dec. 12. 1500 w. 15 cts.

9700. The Latest American Battleships. Philip Hichborn (Describes and illustrates the special features of the Alabama Class). Eng News—Dec. 10. 1800 w. 15 cts.

9740. Cruisers with Rams. (Describes a class of cruisers now being built in the British dockyards. They are as effectively armed as ordinary cruisers, but special attention has been given to the strengthening of the ship forward, so that they may use their ram without the least fear of serious damage). Engng—Dec. 4. 1300 w. 30 cts.

9752. The Trials of the Powerful (Describes the successful series of trials of exceptional severity of Her Majesty's first-class cruiser Powerful, built and engined by the Naval Construction and Armament Co., of Barrow-in-Furness). Eng, Lond—Dec. 4. 3600 w. 30 cts.

9900. The Foudroyant and the Santa Fe. A Comparison of Then and Now. (Illustration and description of two vessels, the contrast in which exemplifies the advance which has taken place not only in warship building, but in hte whole art of mechanical construction). Sci Am Sup—Dec. 19. 1200 w. 15 cts.

9951. The Russian Volunteer S. S. "Kherson." (Illustrated description). Engng—Dec. 11. 2000 w. 30 cts.

9998. The New Torpedo Craft of the United States Navy. R. G. Skerrett (Illustrated description, with table giving general particulars and principal dimensions of the boat). Harper's Weekly—Dec. 26, 1896. 1200 w. 15 cts.

10002. Secretary Herbert's Report on the Texas (Editorial criticism of the report). Sci Am—Dec. 26, 1896. 1500 w. 15 cts.

10005. Armor for Fortifications. From Der Stein der Weisen (Showing how armor has become more and more indispensable on account of the development of projectiles, and how the struggle between guns and armor is no longer restricted to naval warfare). Sci Am—Dec. 26, 1896. 1400 w. 15 cts.

10038. Her Majesty's Battleship Prince George. (An illustrated description of this great battleship, which is one of a series of nine similar vessels). Eng Lond—Dec. 18, 1896. 18000 w. 30 cts.

10154. The Machinery of the SS. Kherson (Illustrated description). Engng—Dec. 25, 1896. 2500 w. 30 cts.

MISCELLANY.

9653. Progress and Promise in American Ship-Building, II. Lewis Nixon (Antagonizing the policy of freedom in the ship-building industry, and showing the dependence of the steam marine on governmental aid). Eng Mag—Jan. 4200 w. 30 cts.

9685. Turret Deck Steamers (Illustrated description of one of the latest designs of this class, which embodies the best features of the whale-back and the ordinary cargo steamer). Sci Am Sup—Dec. 12. 500 w. 15 cts.

9739. Fiske's Helm Indicator and Steering Telegraph (Illustrated description of these two instruments, which have attained very great success in an extended series of trials in the war vessels of the United States). Engng—Dec. 4. 1400 w. 30 cts.

9754. The New P. and O. Steamship India (History of the Peninsular and Oriental Steam Navigation Company, the oldest and largest shipping concern in existence, followed by an illustrated description of this latest addition to the company's fleet). Eng Lond—Dec. 4. 4800 w. 30 cts.

9841. The Computation of the Resistance of Ships (Berechnung des Schiffswiderstanden) Prof. Th. Maryniak (A development of a formula for computing the resistance of ships from the principles of hydrodynamics, with numerous applied examples). Zeitschr. d. Oesterr Ing u Arch Vereines. Dec. 4, 1896. 1200 w.

9935. The New Marine Power (Describes the Secor Direct Propulsion system, and the works of the company on New York Bay). Sea—Dec. 17. 1500 w. 15 cts.

9956. Canal, River and Lake Communication and Mercantile Marine in Hungary (History of water communication in Hungary, and of what has recently been done to facilitate water transport). Eng Lond—Dec. 11. 4000 w. 30 cts.

10004. The Hudson River Steamer Adirondack, of the People's Line (Illustrated description). Sci Am—Dec. 26, 1896. 1700 w. 15 cts.

10083. New Electric Bell Buoy in Boston Harbor (Illustrated description of three buoys placed along the deep-water channel in Boston harbor. They are connected with and generated from Castle Island. The principles are explained). Elec Eng—Dec. 30, 1896. 1400 w. 15 cts.

10155. Shipbuilding and Marine Engineering in 1896 (Review of the year in the United Kingdom). Engng—Dec. 25, 1896. 3200 w. 30 cts.

10182. Unification of Time at Sea (An attempt to explain why the change of time recommended by Sir John Herschel nearly a half century ago has not become an accomplished fact, and why it has hitherto attracted so little attention and received so little consideration). Trans—Dec. 25, 1896. 2500 w. 30 cts.

10265. A New Submarine Boat (Illustrated description of an invention of Mr. Simon Lake. The Columbia Iron Works, of Baltimore, are to build the boat for experimental work. Compressed air and electricity enter largely into its operation). Mfrs Rec—Jan. 8, 1897. 1000 w. 15 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

9676. Boiler Explosion of the Centralia Colliery, Centralia, Pa. (Illustrated description). Power—Dec. 700 w. 15 cts.

9755. Internal Corrosion in Steam Boilers. (Report of paper by Mr. Sinclair Couper, read before the Inst. of Engs. and Shipbuilders in Scotland. Deals with the many theories which have been adduced to account for corrosion). Eng, Lond—Dec. 4. 3,500 w. 30 cts.

9942. Boiler Efficiency, Capacity and Smokelessness, with Low-Grade Fuels. William H. Bryan (Discusses the best method of expressing the economic performance of a boiler, the ways it may be measured, table with abstract of the results of a number of boiler trials, &c). Jour of Assn of Engng Soc—Nov. 3500 w. 30 cts.

9957. Experiments with Superheated and Saturated Steam in a 500 Indicated Horse-Power Sulzer Compound Engine. B. Donkin (Summary of experiments undertaken at a cotton mill in Bavaria to test a separately fired Schwoerer superheater supplying steam to a compound condensing Sulzer engine). Eng Lond—Dec. 11. 1600 w. 30 cts.

10010. Heat Transmission Through Metal Cylinders. Lieut.-Col. English and Bryan Donkin (Results of a series of trials to ascertain the actual temperatures in the interior of the metal, to observe the exact appearance of the film of water deposited, and to determine whether such a phenomenon as cloudy steam really exists. General arrangement of the apparatus is illustrated. Engng—Dec. 18, 1896. 3000 w. 30 cts.

10040. Government Boiler Inspection (Editorial comment on the effort to promote a bill in Parliament to provide for the compulsory inspection of steam boilers. Thinks such inspection might prove mischievous, and that it is very unlikely that it would be of service). Eng Lond—Dec. 18, 1896. 1,500 w. 30 cts.

10101. Comparative Cost of English and American Boilers (Data received from Mr. George I. Rockwood, who has recently returned from Europe, concerning the relative prices of steam boilers in England and in the United States, illustrating the wide difference in the practice of the two countries). Eng News—Dec. 31, 1896. 1,300 w. 15 cts.

10139. Beekman Automatic Forced Draft Apparatus (Describes a system of furnishing forced draft to steam boiler furnaces by means of one or more fans driven by engines). Mas St Fit—Dec., 1896. 1,800 w. 15 cts.

10263. Systematic Boiler Designing. H. M. Morris (An article intending to point out the line along which engineers think and work in this branch, indicating the mode of procedure from start to finish when considering the design of a complete boiler). Mach—Jan., 1897. Serial, 1st part. 2,000 w. 15 cts.

COMPRESSED AIR.

9658. The Rise of the Young Giant. Compressed Air, Ill. Curtis W. Shields (Reviewing the ever-increasing applications of compressed air as a motive power). Eng Mag—Jan. 4300 w. 30 cts.

9778. The Use of Compressed Air at a Blast Furnace Plant. Ralph H. Sweetser (Illustrated description of the plant of a furnace of the Maryland Steel Co., Sparrow's Point, Md., which has been used with much success during the past year). Compressed Air—Dec. 1000 w. 15 cts.

9790. Compressed Air; Its Generation, Transmission and Application, with Special Reference to Its Use in Railroad Shops. Curtis W. Shields (Presents in a brief form some of the more important facts concerning the methods of generating compressed air, laws governing air compressing, &c. Illustrations and discussion). New York RR Club—Nov. 19. 15500 w. 45 cts.

9904. A Light-Ship Compressed Air Plant (Illustrated description of plant upon lightship No. 42). Am Mach—Dec. 17. 1200 w. 15 cts.

9967. Some of the Uses and Advantages of Compressed Air. J. H. McConnell (Read before the Western Ry. Club. Shows the rapid progress made in the application of compressed air to railway shop work). Ry Rev—Dec. 19. 2300 w. 15 cts.

9993. Compressed Air in Railway Work. William S. Aldrich (Reviews its application to street railway work, mine haulage, motive power, &c. Considers a combined system for street railway work desirable). Am Elect'n—Dec., 1896. 2800 w. 15 cts.

9999. Economy in Compressed Air. Curtis W. Shields (Comparison between air pumps and compressors, with use and advantages of compressors). Engng Mech—Dec., 1896. 1800 w. 30 cts.

10094. Compressed Air Recoil Cylinders for Heavy Mortars (Illustrated description of design by H. A. Spiller). Sci Am—Jan. 2, 1897. 600 w. 15 cts.

10219. Economical Uses of Compressed Air. J. H. McConnell, at Western Railway Club (The many uses of air in machine shops, with special notice of certain uses and comment on the progress). Loc Engng—Jan., 1897. 1,000 w. 30 cts.

10264. Compressed Air for Hoisting Purposes. John L. Klindworth (Favoring the use of air hoists and calling attention to special points). Mach—Jan., 1897. 1400 w. 15 cts.

10266. Compressed Air for City and Suburban Traction. Herman Haupt (Presents the subjects of air motors, briefly stating some of the properties of air and the laws that govern its compression, expansion and distribution; also such properties of steam as enter into the consideration of the questions at issue). Jour Fr Inst—Jan. Serial. 1st part. 4,500 w. 45 cts.

ENGINES AND MOTORS.

9683. Benzine Motor Cycle (An illustrated description of a machine made in Munich, Bavaria, and brought to this country by Mr. Henry Hirsch). Sci Am—Dec. 12. 1800 w. 15 cts.

9722. Internal Combustion Engines. C. W. Hart and C. H. Parr (A thesis submitted for the degree of B. S. in mechanical engineering. Reviews briefly the experimental period of gas engines and discusses some of the applications. A few engines are illustrated and described. Covers the most important work which has been done in developing the internal combustion engine). Wis Eng—Oct Serial, 1st part. 3500 w. 45 cts.

9750. The Motor Car in England in 1896 (Considers the characteristic features of the motor car of 1896, as shown in England. Considers it very far from possible perfection). Eng Lond—Dec. 4. 2000 w. 30 cts.

9756. On the Use of Steam Engines. W. H. Hoffman (Lecture before Boston No. 12, N. A. S. E. as reported by A. J. Guernsey. Notes of the design, construction and use of steam engines). Safety V—Dec. 1600 w. 15 cts.

9757. Setting the Valves of the Brown Engine. Thomas Hawley (An article written some time ago and published by request of the educational committee of the various N. A. S. E. associations. Illustrated description of the Brown engine with directions for setting the valves). Safety V—Dec. 2500 w. 15 cts.

9762. Electrically Controlled Gas Motor (Illustrated description of an electrically controlled gas engine or motor, devised primarily for use in automatic railroad signals, but adapted to any purpose requiring a periodical motor). Ir Tr Rev—Dec. 10. 1600 w. 15 cts.

9852. Turbines and Their Regulators Exhibited at Geneva (Die Turbinen und deren Regulatoren auf der Schweiz. Landesausstellung in Genf 1896). Franz Prásil (A most valuable series of illustrated articles describing the latest forms of Swiss turbines and governors. Seven articles, with many illustrations). Schweizerisches Bauzeitung—Nov. 14, 21 and 28, and Dec. 5, 12, 19 and 26. 16,000 w.

9905. Safety Stop Attachment for Power-House Engines (Illustrates the attachment applied by the E. P. Allis Co. to the engines driving the electric generators of the Lenox avenue line of the Metropolitan Traction Co. of N. Y. They are equally applicable to engines doing other duty). Am Mach—Dec. 17. 450 w. 15 cts.

10001. The Use of Acetylene for Motors (An abstract translation of article by A Von lhering in the "Journal für Gasbeleuchtung." A summary of researches by himself and others in the use of acetylene in gas motors). Jour Gas Lgt—Dec. 15 1896. 700 w. 30 cts.

10008. Triple-Expansion Pumping Engine (Illustrated description of pumping plant, designed by B. V. Nordberg, to do certain work outlined by the Commissioners of the District of Columbia, U. S. A.). Engng—Dec. 18, 1896. Serial. 1st part. 2500 w. 30 cts.

10031. Neutral and Reverse Compounding. Charles M. Jones (Showing that cylinders of equal volume may be compounded in single series, and that engines may be constructed in which the higher pressured cylinders are of greater volume than the cylinders which they supply with steam). Eng—Dec. 19, 1896. 1,200 w. 15 cts.

10066. Compression as a Factor in Good Running Engines (Shows the benefit of compression in a condensing engine, as well as a non-condensing, if the compression is properly obtained). Eng Rec—Dec. 26, 1896. 500 w. 15 cts.

10146. Vertical Compound Engine at Warren, R. I. (Illustrated description of new engine). Power—Jan., 1897. 600 w. 15 cts.

10224. A Novel Engine Design (Illustrated description of a novel steam engine designed by L. Hollingsworth, Jr.). Am Mach—Jan. 7, 1897. 1,000 w. 15 cts.

10259. Designing an Engine Shaft Governor. Theo. F. Scheffler, Jr. (General description of the governor and the mechanical theory, showing how it controls the steam valve; followed by details). Mach—Jan., 1897. Serial. 1st part. 2000 w. 15 cts.

POWER AND TRANSMISSION.

9697. Power from the Tides (Gives illustrated description of a tidal motor, the invention of Edward Davies, and explains the working of the arrangement). Can Eng—Dec. 1,700 w. 15 cts.

SHOP AND FOUNDRY.

9660. Tests of Novel Types of Ball Bearings (Presents the result of tests made by George D. Rice, of Medford, Mass., of several types of ball bearings, with illustrations). Ir Age—Dec. 10. 1000 w. 15 cts.

9671. A. 57-Inch Lathe (Describes an interesting lathe recently built for the Union Iron Works, San Francisco. Two half tones and the plan, elevation and cross-section give a good idea of the lathe). Am Mach—Dec. 10. 600 w. 15 cts.

9672. A Diagram for Determining Diameters of Solid Round Shafts Subject to Bending and Twisting, and Arrangement of Drawing-Room Bluebook. Henry Hess (Diagram, with directions for use, and example). Am Mach—Dec. 10. 1000 w. 15 cts.

9763. Utility of the Test Bar and Standard Systems for Comparative Tests. Thomas D. West (Read before the Foundrymen's Assn. Calls attention to various points in tests presented, and shows that the true utility of the test bar is simply comparative). Ir Tr Rev—Dec. 10. 2000 w. 15 cts.

9902. Cycle Stampings. Hugh Dolnar (Illustrated description of work and one set of tools of Matthews Co., of Seymour, Conn.). Am Mach—Dec. 17. 2800 w. 15 cts.

10028. Economical Production in Engineering Workshops (An effort to show how to produce work at the lowest possible cost, without any drawbacks). Mach, Lond—Dec. 15, 1896. Serial. 1st part. 1700 w. 30 cts.

10089. Accurate Work on Lathe and Planer by Use of Solder. A. H. Cleaves (Illustrated description of methods). Am Mach—Dec. 31, 1896. 1000 w. 15 cts.

10090. Special Drives. John Randol (Presents the convenience and economy of arranging some means by which power can be delivered at any place on the shop floor where it is required). Am Mach—Dec. 31, 1896. 2,300 w. 15 cts.

10127. The Founding of Statuary. Horace G. Belcher. (Illustrated description of the work as executed in the foundry of Gorham Mfg. Co., at Elmwood, near Providence, R. I. Describes also the foundry, furnaces, ovens, &c.). Foundry—Dec., 1896. 3400 w. 15 cts.

10129. The Manufacture of Charcoal for Foundry Purposes. L. S. Brown (Describes and illustrates methods of burning and calls attention to points where its use would be economical). Foundry—Dec., 1896. 2700 w. 15 cts.

10130. Physical Tests of Cast Iron in the Foundry. James A. Beckett (Showing that such tests are a necessity; discussing the transverse test, and the methods). Foundry—Dec., 1896. 1800 w. 15 cts.

10131. Down Draft Core Oven. W. L. Hayden (Part first is an illustrated description of the details above ground). Foundry — Dec., 1896. Serial. 1st part. 1200 w. 15 cts.

10132. The Arch-Enemy and How to Control It. L. C. Jewett (Discusses "vent," or the outlet for pent-up gases). Foundry—Dec., 1896. 1200 w. 15 cts.

10156. Defects in Cast-Iron Castings (A foreman moulder presents the practical aspect of the question. Emphasizes the importance of making a good mould). Engng—Dec. 25, 1896. 1500 w. 30 cts.

10223. Long Gear Teeth. Horace L. Arnold (A discussion of the subject from a machine shop point of view). Am Mach —Jan. 7, 1897. 2000 w. 15 cts.

10229. The South's Foundry Interests. E. H. Putnam (Progress in the past the index for the outcome in the future). Tradesman—Jan. 1, 1897. 4500 w. 15 cts.

10260. Brass Foundries (Part first gives information of furnaces used). Mach—Jan., 1897. Serial. 1st part. 1300 w. 15 cts.

10261. Lathe Cones and Back Gears. R. E. Marks (Explanation of these questions which often trouble mechanics and draughtsmen). Mach—Jan., 1897. Serial, 1st part. 900 w. 15 cts.

10262. Machining Cycle Forgings. Onondaga (A description in detail of the method of machining the bottom bracket forgings, and the proper method of designing the forgings is illustrated and described, also tools and special jigs used). Mach — Jan., 1897. Serial. 1st part. 1400 w. 15 cts.

MISCELLANY.

9657. Labor-Saving Machinery, the Secret of Cheap Production. A. E. Outerbridge, Jr. (Showing that an ascending wage-scale is an essential of prosperous productivity). Eng Mag—Jan. 3,200 w. 30 cts.

9679. Insulation of Steam Pipes by Means of Zinc and Tinplate Jackets. Dr. Jsh. Russner (Translated from Wochenblatt für Papierfabrikation, showing that by a proper arrangement of zinc and sheet jackets a system of steam pipes can be as well protected against loss of heat as with the best insulating material now in use). Power—Dec. 1,100 w. 15 cts.

9680. Experimental Determination of the Efficiency of Pipe Coverings. F. G. Gasche (Explains a method of investigation, apparatus used, &c.). Power—Dec. 3,000 w. 15 cts.

9720. Abrasives. A. L. Goddard (A general review of abrasives now used and the methods employed). Wis Eng—Oct. 3,300 w. 45 cts.

9724. A Comparative Test of Steam Injectors. G. H. Trautmann (Abstract of a thesis for the degree of B. S. in mechanical engineering. The object of the work described was to test each of eight injectors according to a definite system so that they could be compared exactly in every detail carried out. Curves given show the effects of changing the feed-water temperature). Wis Eng—Oct. 1,000 w. 45 cts.

9737. Canet's Quick-Firing Field Guns (Describes the Canet new model, an important type of quick-firing gun combined with a carriage, and the different ways in which the desired conditions have been partially attained). Engng—Dec. 4. Serial, 1st part. 1,800 w. 30 cts.

9774. A Geometrical Solution of the Problem of Finding the Radii of Different Pulleys, so that the Same Open Belt Shall Fit Each and Every Pair. W. J. Varley (Solution illustrated by seven diagrams). Elec Rev, Lond—Dec. 4. 700 w. 30 cts.

9779. The Andre System of Gas Heated Ovens. P. Chevillard, in Revue Industrielle (Describes an oven used in heating iron moulds used in the manufacture of glass lenses, and considers the wider application to ovens for bakers, pastry cooks, &c. Illustrations). Am Gas Lgt. Jour—Dec. 14. 2,000 w. 15 cts.

9780. The Hopeful Outlook in the Mechanical World (Testimonies of great industrial concerns regarding the condition of business since the Presidential election of 1896; a symposium). Eng Mag—Jan. 3,800 w. 30 cts.

9808. Germanisms and Americanisms in Technical Methods (Teutonismus und Amerikanismus in der Technik) (The first portion of an interesting comparison of the methods of the two nationalities. This article considers the present German practice as the result of three influences, i. e., the old "handwerk," modern "book learning" and an admixture of English methods). Deutsche Zeitschrift für Elektrotechnik—Oct. 15. 1400 w.

9835. Automatic Air Relief Device for Siphons (Automatische Entluftungs-Vorrichtung fur Heberleitungen). Rudolf Muller. (A descriptions with illustrations of the apparatus constructed for the purpose of automatically relieving the siphon in the Bielitz water supply main affair, by a system of traps and floats). Oesterr. Manatschr. f. d. Oeff. Bau—Dec. 1896. 6000 w.

9847. Machinery at the Geneva Exposition (Les Machines a l'Exposition de Genéve). (An editorial notice of the machine exhibits, including boilers, engines, hydraulic motors and machine tools). La Révue Technique—Nov. 10, 1896. 6,000 w.

9848. The Loewe Machine Tools at the Berlin Exhibition (Les Machines-Outils Loewe à l'Exposition de Berlin). (Description, with excellent illustrations, of some of the Belgian copies of American machine tools). La Révue Technique—Nov. 10, 1896. 3,500 w.

9901. Machine for Tapping Water Mains (Illustrated description of machine for cutting a hole in a main pipe and making a secure connection for a branch or outlet without shutting off the pressure). Am Mach—Dec. 17. 700 w. 15 cts.

9903. Valuation of Manufactories. Oberlin Smith (A discussion of the appraiser's work, and advocating the rating of things a little too low, rather than too high). Am Mach—Dec. 3,300 w. 15 cts.

9954. The Potential of Steam. Howard Pentland (Read before the Inst. of Civ. Engs., Ireland. Suggesting the estimating of saturated steam, expanded steam and electricity all by work, instead of by different means). Mech Wld—Dec. 11. Serial. 1st part. 1,700 w. 30 cts.

9964. Management of Steam Plants. M. W. Danielsen (The importance of giving attention to small things). Age of St—Dec. 19. 1,400 w. 15 cts.

9979. Quartz Fibres. C. Vernon Boys (The method of making and applying quartz fibres. Instruction with practical details). Elect'n—Dec. 11, 1896. Serial. 1st part. 3,300 w. 30 cts.

9994. Friction and Lubricating Oils. C. A. Collett (The laws of friction are discussed in Part I. A succeeding article will discuss in detail the various kinds of lubricating oils). Am Elect'n—Dec., 1896. 1300 w. 15 cts.

10009. American Machine Tools (Editorial comment on the higher perfection of light machine tools made in America). Engng—Dec. 18, 1896. 1,600 w. 30 cts.

10043. Aluminum Bronze Seamless Tubing. Leonard Waldo (Describes process of making, with difficulties. Abstract of a paper presented at the N. Y. meeting of the A. S. M. E). Eng News—Dec. 24, 1896. 1,000 w. 15 cts.

10049. Status of Apprenticeship in the Trades Concerned in the Production of Machinery (Letters from 116 of the most prominent machinery building establishments and important railway systems of the country, stating their practice and views regarding apprenticeship). Am Mach—Dec. 24, 1896. 24,000 w. 15 cts.

10091. A New Formula and Diagram for Combined Stresses in Shafts. A. L. Hopkins (Explains the deduction of a formula which the writer thinks should be not only convenient for general use and permit of a graphic representation, but which would also give results agreeing closely with those obtained by the use of the Rankine and Grashof formulae). Am Mach—Dec. 31, 1896. 2,000 w. 15 cts.

10095. The New Polarizing Photo-Chronograph at the United States Artillery School, Fort Monroe, Va. Albert Cushing Crehore and George Owen Squier (Illustrated description of this instrument and its installation, with some of the further tests and experiments with it which were carried out in the electrical laboratory of the school where the new instrument was installed). Sci Am Sup. Jan. 2, 1897. 9,000 w. 15 cts.

10168. Coal Handling Machinery at the Yard of J. T. Story, Brooklyn, N. Y. Built by the C. W. Hunt Co. (Illustrated description of a successful plant with a daily capacity of 600 or 700 tons). Am Eng & RR Jour—Jan, 1897. 1,600 w. 30 cts.

10199. The Manufacture of Bicycle Tubing (Illustrated detailed description of the plant of the Pope Tube Co., of Hartford, Conn., manufacturers of steel bicycle tubing). Ir Age—Jan. 7, 1897. 4,800 w. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

9744. "Afterdamp." T. Getrych Davies (A description of its effects and some peculiar experiences with it at several explosions. From Proceedings of South Wales Inst. of Min. Engs.). Col Eng—Dec. 2,000 w. 30 cts.

9746. The Regulation of the Output of Coal in South Wales (Report of the owners' representatives on the Sliding Scale Joint Committee upon the question of the undue competition in the coal trade). Col Guard—Dec. 4. 2,800 w. 30 cts.

9946. The Westphalian Coal Field in Germany. A. Kowatsch (Descriptive account). Eng & Min Jour—Dec. 19. 1,100 w. 15 cts.

9961. Irruptions of Coal in Mine Workings. F. G. Meachem (Notes on irruptions of Hamstead Colliery, South Staffordshire, read at meeting of Manchester Geol. Soc. Suggestions as to the causes). Col Guard—Dec. 11. 1,800 w. 30 cts.

9962. The Treatment of Coal at the Pit Bank (Two papers read before the Inst. of Civ. Engs. The first, "Screening and Tipping Coal," by James Rigg; the second, "The Surface Plant at Kirkby Colliery," by Thomas Gillott. Abstracts). Col Guard—Dec. 11. 1,200 w. 30 cts.

9963. Experiments with a Ser Fan at the Saint-Eloy Colliery for Determining the Equivalent Orifice. M. de Lachapelle (From a communication to the Société de l'Industrie Minerale. Experiments made in the passage orifice of the fan drift connected with the upcast shaft). Col Guard—Dec. 11. 1,200 w. 30 cts.

10029. Coal Cutting by Machinery. W. Blakemore (A description of the machines in use at the Dominion No. 1 mine, which was especially laid out for the purpose of machine mining. Illustrated). Can Min Rev—Dec., 1896. Serial. 1st part. 3,400 w. 30 cts.

10061. A Saxon Coal Mine. E. R. Schoch (Brief description of mine, method of coal getting, &c). Eng & Min Jour—Dec. 26, 1896. 900 w. 15 cts.

10062. An Illinois "Solid-Shooting" Mine; the Virden Shaft (Illustrated description of the property of the Chicago-Virden Coal Co.). Eng & Min Jour—Dec. 26, 1896. 1,000 w. 15 cts.

10160. Nova Scotia Coals as Steam Producers. F. H. Mason and W. G. Matheson (The object of the paper is to place on record some results obtained from an analysis of samples of coal from the various mines of Nova Scotia). Col Guard—Dec. 24, 1896, 2,300 w. 30 cts.

10181. The Coal Industry in 1896 (A review of the industry in Great Britain, shows the production to be probably the highest on record, but the prices unsatisfactory. The article deals with prices, production, labor disputes, &c). Ir & Coal Trd Rev—Dec. 24, 1896. Serial. 1st part 7,000 w. 30 cts.

10240. Coke Making and Southern Coals. John S. Kennedy (The salient points of difference between the old and the new practice). Tradesman—Jan. 1, 1897. 2,000 w. 15 cts.

10241. The Coal Interests of the South. J. J. Ormsbee (Historical and statistical review of the work of the past year). Tradesman—Jan. 1, 1897. 4,500 w. 15 cts.

10242. The Coal Interests of the South. Jesse T. Hill (A review of the mining operations in each of the Southern States. Tradesman—Jan. 1, 1897. 1800 w. 15 cts.

COPPER.

9984. The Alloys of Copper and Zinc. T. K. Rose (The researches of M. G. Charpy which have notably advanced knowledge of this subject). Nature—Dec. 10, 1896. 1,300 w. 30 cts.

10052. Copper Refining by Electricity (A brief review of the main difference between the two classes of copper-refining processes, with remarks on the lack of wisdom of copper refiners in not publishing results and comparing notes). Min & Sci Pr—Dec. 19, 1896. 1200 w. 15 cts.

GOLD AND SILVER.

9668. The Losses of Fine Gold in Gippsland. Donald Clark (An interesting description of losses in the mountainous gold field in Victoria). Aust Min Stand—Oct. 29. 4,000 w. 30 cts.

9669. The New Discoveries in Gippsland, Victoria (Late discoveries in Eastern Gippsland as reported by Reginald Murray) Aust Min Stand—Nov. 5. 1,300 w. 30 cts.

9670. Yowaka, or Pambula, Gold Field, New South Wales. J. E. Carne (Illustrated detailed description). Aust Min Stand—Nov. 5. Serial, 1st part. 5,500 w. 30 cts.

9689. The Gold Belt of Pitkin, Gunnison County, Col. J. R. Holibaugh (Describes the location and formation of the belt and some of the well-developed properties). Eng & Min Jour—Dec. 12. 900 w. 15 cts.

9741. Twin Lakes Region. J. J. Guentherodt (Description of a rich placer and gold mining district of Colorado which has been but little developed). Col Eng—Dec. 1,600 w. 30 cts.

9742. The San Juan Region. Arthur Lakes (A description of a rich mining field and its developments. The Spanish peaks, the geological history, the ore deposits and mining characteristics are treated in detail). Col Eng—Dec. 5,400 w. 30 cts.

9743. Victor (Cripple Creek), Colorado. Arthur Lakes (An account of a gold-bearing vein found while excavating for the foundations of a hotel). Col Eng—Dec. 1,400 w. 30 cts.

9784. Notes on the Estimation of Sulphides and Cyanates in Commercial Cyanide. Messrs. Feldtmann and Bettel (Read at meeting of the Chemical and Metallurgical Society of South Africa. The paper deals with two of the most troublesome estimations in the analysis of cyanide—the estimation of sulphides and cyanates. The first part describes a rapid and accurate method for the estimation of sulphides). Min Jour—Dec. 5. Serial, 1st part. 1,600 w. 30 cts.

9938. The Mineral Deposits of Eastern California. Harold W. Fairbanks (This portion of California has a mineral deposit in many respects different from the rest of the State. The important deposits are gold, silver and lead). Min & Sci Pr—Dec. 12. 1,700 w. 15 cts.

9959. The Gold Fields of the Houraki Peninsula, New Zealand. Joseph Campbell (Describes the characteristics of the gold fields included in each of the counties embraced within the peninsula). Min Jour—Dec. 12. Serial. 1st part. 1,100 w. 30 cts.

9991. The West Australian Gold Occurrences. C. A. Huessler (Observation and conclusions from notes taken in the various fields while touring per bicycle). Aust Min Stand—Nov. 19, 1896. Serial. 1st part. 1,300 w. 30 cts.

10046. Mexico and Its Gold. C. C. Longridge (The increase in the gold output, and the questions of communication, water and fuel. Mexico is considered from its geological and mineralogical standpoint). Min Jour—Dec. 19, 1896. 1,300 w. 30 cts.

10047. The Latest Great Gold Discovery in the United States (The riches of the Mojave Desert in California). Min. Jour—Dec. 19, 1896. 1,800 w. 30 cts.

10072. The Ore-Shoots of Cripple Creek. Edward Skewes (An introductory contains condensed statements from the work of Messrs. Cross and Penrose as reported in the U. S. Geol Survey, and the paper then gives facts concerning the occurrence, and more particularly the pitch of the ore-shoots in the locality). Trans Am Inst of Min Engs—Dec. 1896. 8,500 w. 45 cts.

10073. The Solution and Precipitation of the Cyanide of Gold. S. B. Christy (A discussion of how gold dissolves in cyanide solutions, and how it is precipitated from them. The results of a systematic investigation). Trans Am Inst of

Min Engs—Dec., 1896. 14,000 w. 45 cts.

10148. Gold and Silver (Review of 1896 in the production of these metals, and a comparison with 1895. Gold mining in the South and in Cripple Creek, Leadville, Mexico and other countries are separately treated). Eng & Min Jour—Jan. 2, 1897. 9,500 w. 15 cts.

10230. Metallurgy of Southern Gold. William M. Bowron (The field that was worked in every section prior to the exodus of '49). Tradesman—Jan. 1, 1897. 4,000 w. 15 cts.

IRON AND STEEL.

9661. Four American Rolling Mills. Samuel T. Wellman (Paper read before the Inst. of Civ. Engs. of Great Britain. The author deals more particularly with the machinery and appliances, to save labor and time in handling the piece round the rolls, which have been introduced within the past 10 or 11 years. Illustrated description is given of appliances used in the Joliet Works of the Illinois Steel Co., the South Works of the Illinois Steel Co., South Chicago, Ill.; the new rail mill at the Edgar Thomson Steel Works, the plate mill of the Illinois Steel Co., South Chicago). Ir Age—Dec. 10. 4000 w. 15 cts.

9687. Evidence for the Allotropic Theory. Henry M. Howe (Describes experiments made to get light on the effect of allotropy as contributing to the hardening of steel and in the question of stress). Eng & Min Jour—Dec. 12. 800 w. 15 cts.

9851. The Metamorphoses of the Basic Steel Process and the Methods of Testing Steel Rails (Metamorphosen der Basischen Schienenstahlbereitung und des Prufungsverfahrens der Stahlschienen. Prof. L. Tetmaier (A discussion of the basic steel process, especially with regard to its use for rails. Also many illustrations of etched rail sections, showing structure. Five articles). Schweiz Bauzeitung—Nov. 7, 14, 21, 28 and Dec. 12, 1896. 15,000 w.

9953. American and English Methods of Manufacturing Steel Plates. Jeremiah Head (Read before the Inst. of Civ. Engs. Illustrated discussion of the processes used and comparison of methods). Ir Age —Dec. 24. 8,000 w. 15 cts.

10021. The Determination of Sulphur in Cast Iron. Francis C. Phillips (Investigation to ascertain as far as possible whether by a process of direct oxidation of the iron in a dry state a larger proportion of the sulphur could be recovered in weighable form than by the usual method of oxidation and solution in nitric acid). Jour Am Chem Soc—Dec., 1896. 2,200 w. 45 cts.

10022. Carbon Determinations in Pig Iron. Bertrand S. Summers (Illustrated description of apparatus by which the carbon may be determined with reasonable speed and accuracy). Jour Am Chem Soc—Dec., 1896. 900 w. 45 cts.

10030. The Bertrand-Thiel Steel-Making Process. Percy C. Gilchrist (Read at meeting of the Cleveland Institution of Engineers. The process is briefly stated and the results given. Discussion follows). Iron and Coal Trds Rev—Dec. 18, 1896. 2,300 w. 30 cts.

10033. The Lease of the Mountain Iron Mine (Recent arrangements made by the Carnegie Steel Co., Ltd., with editorial comment). Ir Tr Rev—Dec 24, 1896. 2,500 w. 15 cts.

10058. The Testing of Iron and Steel (Introduction to paper by Prof. J. B. Johnson presented at meeting of the St. Louis Ry. Club, with conclusions based on actual tests). R R Gaz—Dec. 25, 1896. 1,900 w. 15 cts.

10063. Residual Stresses in Steel. H. K. Landis (Explains the meaning of the term and the influence; gives a table of effect of cold and hot rolling on endurance; shows that hot rolled bars are less strong and tough than the same material after cold working, &c). Am Mfr & Ir Wld—Dec. 25, 1896. 1,500 w. 15 cts.

10064. Cast Steel in Locomotive Building (Extract from paper by Mr. Barba read before the New England Ry. Club, showing the adaptation of steel to this work). Am Mfr & Ir Wld—Dec. 25, 1896. 1,300 w. 15 cts.

10067. Cast Steel in Locomotive Construction. J. E. Sague (Extract from a paper read before the New England Ry. Club. Reasons which have led to the wide substitution of steel for cast and wrought iron). Ry Rev—Dec. 26, 1896. 2000 w. 15 cts.

10088. Constitution and Properties of Cast Iron. A. J. Rossi (An examination of parts of an article by A. Pourcel, a well-known French metallurgist, published in "Revue des Sciences"). Ir Age—Dec. 31, 1896. 3,000 w. 15 cts.

10128. Carbon in Iron. S. S. Knight (Comments on the slow progress in the chemical and scientific components of the iron industry. Considers the subject of carbon in its relation to iron, and gives the results of experiments). Foundry—Dec., 1896. 1,400 w. 15 cts.

10135. 1896 in the Iron Trade (Review of the production and prices for the year). Ir Tr Rev—Dec. 31, 1896. 1,700 w. 15 cts.

10140. First Principles of Steel Specifications. H. K. Landis (Arguing that a specification defining the qualities which the purchaser desires is not sufficient, but a clause should be added describing the purpose for which the material is intended). Am Mfr & Ir Wld—Jan. 1, 1897. 1,400 w. 15 cts.

10149. The Course of the Iron Markets in 1896 (Yearly review which notes many important changes and fluctuations).

Eng & Min Jour—Jan. 2, 1897. 8,200 w. 15 cts.

10170. The Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer to It. John Fritz (Presidential address presented at the N. Y. meeting, Dec., 1896, of the Am. Soc. of Mech Engs. Part first gives a brief account from its infancy to 1895, and a succeeding article will show the wonderful changes since that time). Am Eng & R R Jour—Jan., 1897. 2500 w. 30 cts.

10174. The Swedish Iron, Steel and Coal Industries in 1895 (A résumé taken from the official report just issued). Eng Lond—Dec. 25, 1896. 1,400 w. 30 cts.

10180. The Iron and Steel Trades in 1896 (Yearly review of these industries in the United Kingdom show advances both absolute and relative). Ir & Coal Trds Rev—Dec. 24, 1896. 3,000 w. 30 cts.

10200. The "Kearsage" and "Kentucky" Plates. W. L. C. (Report of Acting-Secretary McAdoo's views, the report of the Steel Board and comments of Chief Hichborn, of the Bureau of Construction). Ir Age—Jan. 7, 1897. 2,800 w. 15 cts.

10201. The Manufacture and Use of Thomas Slag. F. E. Thompson (This basic slag is the scoria produced in Bessemerizing phosphoritic pig iron according to the patents of Messrs. Thomas & Gilchrist. Its production, chemistry, analysis and use are discussed). Ir Age—Jan. 7, 1897. 4,200 w. 15 cts.

10202. The Pittsburg Iron Trade in 1896 (Review of the year, also discusses in detail the trade in pig iron, steel billets, finished iron and steel, plates and bars). Ir Age—Jan. 7, 1897. 7,400 w. 15 cts.

10203. The Cost of Armor Plate (Summary of Secretary Herbert's letter to Congress). Ir Age—Jan. 7, 1897. 4,000 w. 15 cts.

10226. The Southern Iron Trade. William B. Phillips (Discusses the course with reference to the inspection of materials). Tradesman—Jan. 1, 1897. 10,000 w. 15 cts.

10227. The Bessemer Process. A. M. Shook (The ability of the South to manufacture basic open hearth steel is demonstrated). Tradesman—Jan. 1, 1897. 2500 w. 15 cts.

10228. The Pig Iron Trade. T. P. Wells (A retrospect of its movements in the South in the past year). Tradesman—Jan. 1, 1897. 1,000 w. 15 cts.

10244. Nickel Steel. H. K. Landis (The history, physical and mechanical properties, and the application of this metal). Sci Am—Jan. 9, 1897. 1,800 w. 15 cts.

MINING.

9736. Electricity vs. Compressed Air. Actual Results in a Mine of the Colorado Fuel and Iron Company. Lewis Searing (Practical tests of both systems made under the direction of the writer. Favorable to electricity). Min Ind & Rev—Dec. 10. 2,200 w. 15 cts.

9745. Mining Rights in Germany and Austria-Hungary (Particulars with regard to mining rights in Prussia from the official report by Mr. C. Fortescue-Brickdale. The information was collected at Beuthen, in Silesia, the centre of one of the largest mining districts). Col Guard—Dec. 4. 1,100 w. 30 cts.

9747. The Rise and Progress of Coal Mining. J. B. Simpson (Address delivered before the Newcastle Assn. of Students connected with the Inst. of Civ. Engs. A history of the progress made in the engineering of mines). Col Guard—Dec. 4. 6,000 w. 30 cts.

9748. Use of Expansion in Winding Engines. M. Berne (From a communication to the Societe de l'Industrie Minerale, St. Etienne. The advantages and results in the use of expansion are given). Col Guard—Dec. 4. 3,500 w. 30 cts.

9749. Electric Coal Cutting on Longwall Faces. T. B. A. Clarke (The writer describes briefly the method and apparatus employed in cutting coal electrically; compares electricity as a motive power with compressed air, and gives some results obtained in seams of various thickness by electrically driven machines). Col Guard—Dec. 4, 1,700 w. 30 cts.

9785. Outlines of the Mexican Mining Code. C. C. Longridge. (The introduction of this code is said to have very much simplified mining business, and greatly diminished the occasions for misunderstanding and litigation.) Min Jour—Dec. 5. 1,600 w. 30 cts.

9911. Mining in the Leadville District. Franklin Ballou, Jr. (Interesting account of the marvellous mineral wealth to be found in a single square mile, with brief description of the region and the origin of the deposits). Yale Sci M—Dec. 2,400 w. 30 cts.

9945. The Limonites of Alabama Geologically Considered. Henry McCalley (Description of deposits and their location). Eng & Min Jour—Dec. 19. 1,500 w. 15 cts.

9977. Mining at Great Depths. Bennett H. Brough (An elaborate paper discussing all phases of the subject. It gives a summary of existing literature on the subject and observations of the writer). Jour Soc of Arts—Dec. 11, 1896. 11,400 w. 30 cts.

10035. Mechanical Haulage with Electric Transmission of Power. M. Dickmann (Illustrated description of two mechanical haulage plants with electric transmission of power at the Heintzmann shaft). Col Guard—Dec. 18, 1896. 2,000 w. 30 cts.

10051. A Colorado Comparison Between Cripple Creek and the Comstock (Reprint of an article from the Denver Republican, with editorial comment on the impossibility of drawing a fair parallel between the two regions). Min & Sci Pr—Dec. 19. 3,000 w. 15 cts.

10074. The Phosphate Deposits of Arkansas. John C. Branner (Describes position, appearance and origin of the deposits, with local details, value and method of mining). Trans Am Inst of Min Engs—Dec., 1896. 6,300 w. 45 cts.

10105. Timber and Wood Consumption in the Comstock Mines. William Alvord (Statistics of the immense amount of costly timbering required and interesting information regarding it. Abstract of a paper in Vol. X of the Pro. of the Am. Forestry Assn.). Eng News—Dec. 31, 1896. 2,800 w. 15 cts.

10142. Is It Profitable to Mine Thin Seams of Coal by Any of the Types of Electrical Mining Machines Now in Use? George Gould (Concludes that it is not profitable unless conditions are favorable, and gives experience). Am Mfr & Ir Wld—Jan. 1, 1897. 1,200 w. 15 cts.

10153. The Mining Stock Exchanges in 1896 (Reports from all the leading exchanges in which there are dealings in American mining stocks). Eng & Min Jour—Jan. 2, 1897. 12,500 w. 15 cts.

10159. Mining Law of Foreign Countries (Reviews and compares the laws of different lands). Col Guard—Dec. 24, 1896. 1,600 w. 30 cts.

10162. Explosives in Coal Mines (Order made by the Sec. of State for the Home Dept.—cited as the Explosives in Coal Mines Order, 1896). Col. Guard—Dec. 24, 1896. 2800 w. 30 cts.

10236. The Mineral Industry of the South. William M. Brewer (Activity in prospecting shows a marked improvement over 1895. Each mineral is briefly discussed). Tradesman—Jan. 1, 1897. 4000 w. 15 cts.

10237. The Manganese Ores of Georgia. William M. Brewer (A mining and shipping industry that has been in operation for over half a century. The system of working is described). Tradesman—Jan. 1, 1897. 2,000 w. 15 cts.

10245. Hoisting Engines for the Anaconda Mine (Illustrated description of the compound hoisting engines—high-pressure cylinder 26 inches diameter, low-pressure cylinders 46 inches diameter, stroke 72 inches). Sci Am—Jan. 9, 1897. 700 w. 15 cts.

MISCELLANY.

9654. The Prospective Resumption of Mining Activity. David T. Day (Reviewing the stagnant condition of the mining industry and its responsiveness to improved economic conditions and processes). Eng Mag—Jan. 4,300 w. 30 cts.

9662. Aluminum Manufacture in Europe. Alfred E. Hunt (Reviews the history of aluminum manufacture, with the processes used, and gives information regarding prices and development). Ir Age—Dec. 10. 3,000 w. 15 cts.

9667. Zinciferous Ores (A detailed description of the F. L. Bartlett process of treatment). Aust Min Stand—Oct. 29. 900 w 20 cts.

9795. The Use of Oxygen in Gaseous Poisoning (Part first is an illustrated description of preventive and rescuing appliances, and will be followed by a code of rules). Pro Age—Dec. 15. 3,500 w. 15 cts.

9948. Value of Different Kinds of Stone Produced in 1894 and 1895. William C. Day (Part first gives particulars of the marble industry in the various States, with the value of the marble produced). Stone—Dec. Serial. 1st part. 1,100 w. 30 cts.

9949. Geology for Quarrymen. Charles Richard Van Hise (Reprinted from 16th Annual Rept. U. S. Geol Soc. Illustrated review of the causes assigned for joints, zone affected by them, their relation to stratigraphy, faults, folds, &c). Stone—Dec. 3,600 w. 30 cts.

9950. Minnesota Sandstones. N. H. Winchell (Extract from Geol and Nat Hist Survey of Minnesota. Descriptive). Stone—Dec. 2,000 w. 30 cts.

9960. The Mineral Industry of the United Kingdom. C. Le Neve Foster (From the second annual report for the year 1895) Col Guard—Dec. 11. 1,800 w. 30 cts.

10020. Metal Separations by Means of Hydrochloric Acid Gas. J. Bird Moyer (From author's thesis presented to the Faculty of the Univ. of Penn. for the degree of Doctor of Philosophy. Investigation of the action of hydrochloric acid gas upon metallic oxides and their salts). Jour Am Chem Soc.—Dec., 1896. 4,400 w. 45 cts.

10070.—Magnetic Observations in Geological Mapping. Henry Lloyd Smyth (The results of experience in tracing magnetic rocks by means of the disturbances produced in the magnetic instruments used. The rocks mapped were the pre-Cambrian rocks, particularly the iron-bearing formations of Algonkian or Huronian age). Trans Am Inst of Min Engs—Dec., 1896. 21,400 w. 45 cts.

10071. The Use of the Tremain Steam-Stamp with Amalgamation. Edwin A. Sperry (Vertical sections and description of the Tremain steam-stamp, with points of interest in regard to mill-practice in this line). Trans Am Inst of Min Engs—Dec., 1896. 2,400 w. 45 cts.

10075. Traces of Organic Remains from the Huronian (?) Series, at Iron Mountain, Mich., etc. W. S. Gresley (Illustrated description of traces of fossils discovered). Trans Am Inst of Min Engs—Dec., 1896. 3000 w. 45 cts.

10096. Gem Fields of the World. George F. Kunz (Information of the localities where different gems are found and of the methods of mining). Sci Am Sup—Jan. 2, 1897. 2,200 w. 15 cts.

10141. Action of Blast Furnace Gases Upon Various Kinds of Ores. F. E. Bachman (Additional information given in discussion of paper on this subject by O. O. Laudig, from Trans Am Inst of Min Engs). Am Mfr and Ir Wld—Jan. 1, 1897. 2,500 w. 15 cts.

10147. United States Mineral and Metal Production in 1896 (Review of the year in the production of minerals and metals, with table; also antimony and copper in this and other countries, as to production, value, &c.). Eng & Min Jour—Jan. 2, 1897. 4,500 w. 15 cts.

10150. The Mineral Industries in the South. W. M. Brewer (Sketch of progress in the mineral-bearing sections of Georgia and Alabama). Eng & Min Jour—Jan. 2, 1897. 1,800 w. 15 cts.

10151. Lead and Other Minerals (Reviews the market for 1896 in lead, nickel, quicksilver, tin, zinc and coal). Eng & Min Jour—Jan. 2, 1897. 11,800 W. 15 cts.

10246. To Experiment with Different Alloys for Coinage (Brief account of experiments being conducted at the Mint in Philadelphia). Sci Am Sup—Jan. 9, 1897. 600 w. 15 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

9692. Some Notes on the Comparative Cost of Supplying Light by Gas and Electricity in Manchester. G. E. Stevenson (Read before the Manchester District Inst of Gas Engs. Generally favorable to the gas industry. Followed by discussion). Jour. of Gas Lgt.—Dec. 1. 6,000 w. 30 cts.

9693. Illuminating Power as Exhibited in the Parliamentary Returns. Thomas Newbigging (Read before the Manchester Dist. Inst. of Gas Engs. Investigations made with a view to ascertaining the money value of the concession made to the gas consumer). Jour Gas Lgt—Dec. 1. 1,200 w. 30 cts.

9694. Notes on Sulphate of Ammonia. T. N. Ritson (The importance of the product in agriculture, and the need of spreading information on this subject, with tables and diagram giving the relative prices of sulphate of ammonia and nitrate of soda from 1890 to 1895). Jour Gas Lgt—Dec. 1. 2,200 w. 30 cts.

9914. Some Plain Words About City Gas Supplies (Discusses the bad system of managing this business as manifested in Boston, Brooklyn and New York, and suggests the principles on which the supply of a city should be managed). Eng News—Dec. 17. 2,000 w. 15 cts.

9936. Discussion of Mr. Newbigging's Paper on "Illuminating Power as Exhibited in the Parliamentary Returns." Jour Gas Lgt—Dec. 8. 2,400 w. 30 cts.

GAS SUPPLY.

9937. Discussion of Mr. Ritson's paper on "Sulphate of Ammonia." Jour of Gas Lgt—Dec 8, 2,300 w. 30 cts.

9943. Gas Producers and the Mechanical Handling of Fuel for Same. C. L. Saunders (Discusses the rapidity with which producer gas is gaining recognition, the types of producers, processes and the important questions and details necessary to efficiency). Jour of Assn of Engng Soc—Nov. 2,200 w. 30 cts.

9955. Acetylene Gas (Information derived from sources believed to be reliable. Partly abstracted from a pamphlet issued by the Acetylene Illuminating Co. History and causes of danger). Eng Lond—Dec. 11. 1,300 w. 30 cts.

10123. Elusive Leakages from Mains and Services. H. Tobey (Read before the North of England Gas Managers' Assn. Experience of the writer in tracing leakages to their source). Gas Engs' Mag—Dec. 10, 1896. 2,500 w. 30 cts.

10124. The Permanency of Illuminating Gas. William Young (Read before the N. Brit. Assn of Gas Managers. Discusses on what the permanency depends, refers to the Aitken and Young system of condensing crude coal gases, &c). Gas Engs' Mag—Dec 10. 1896. Serial. 1st part. 2,800 w. 30 cts.

SEWERAGE.

9711. The Treatment of Sewage by Chemicals in Perfect Solution. Herbert Henry Law (Read at the Newcastle Congress of the Sanitary Inst. Brief statement of difficulties, and short description of proposed treatment at Oldham). San Plumb—Dec. 1. 1,000 w. 15 cts.

9735. Sewage Irrigation in Europe and America. H. Alfred Roechling (Read at the Congress of the Sanitary Inst., Newcastle. The term "sewage irrigation" as used includes all forms of applying sewage to land. Part first is a general consideration of the subject). San Rec—Dec. 4. Serial. 1st part. 1,800 w. 30 cts.

9751. Manchester Sewage Disposal Scheme (Discusses the modified scheme now adopted). Eng Lond—Dec. 4. 2,000 w. 30 cts.

9928. The Philadelphia & Reading Railroad Subway and Tunnel in Philadelphia. Walter Atlee (Illustrated description of the reconstruction of the sewer system in the portion of the city necessitated by the change of grade. New sewers were required in the heart of the city, almost entirely built up, and it was decided wherever practicable to build them in the tunnel. 63½ per cent. of the whole work was carried on in tunnel). RR Gaz—Dec. 18. 1,400 w. 15 cts.

9978. An Experiment in Sewage Treatment. (The suggestion of W. J. Dibdin, and the trial made. The cultivation of sewage-devouring bacteria). San Rec—Dec. 11, 1896. 1,100 w. 30 cts.

10026. The Ultimate Purification of Sewage. George Thudichum (Read before the Soc of Engs. Describes some of the more important features of biological filtration, with a comparison between filtration and irrigation, and results of various experiments). San Rec—Dec. 18, 1896. Serial. 1st part. 2,000 w. 30 cts.

10065. Methods for the Quantitative Determination of Bacteria in Sewage and Waters. George W. Fuller and William R. Copeland (Abstract of paper in Massachusetts State Board of Health Report for 1895, describing methods used at the experimental station at Lawrence). Eng Rec—Dec. 26, 1896. 4,000 w. 15 cts.

10115. Worcester Street Drain Syphon at Newton, Mass. H. D. Woods (Illustrated description of work made necessary by the depression of the four tracks of the Boston and Albany Railroad). Eng Rec—Jan 2, 1897. 800 w. 15 cts.

STREETS AND PAVEMENTS.

9702. A Notable Departure in Macadam Road Construction (Discusses the value of macadam roads, their cost, and wearing qualities; calls attention to an improved construction recently tried in Monmouth, Ill., which consists of a combination of brick pavement and macadam; gives cross-section). Eng News—Dec. 10. 1,600 w. 15 cts.

10013. Specifications for Cement Walks (Suggestions submitted, covering in a general way the proper methods and materials to be used in the building of cement walks). Br Build—Dec, 1896. 800 w. 30 cts.

WATER SUPPLY.

9760. The Use and Misuse of Water. R. E. W. Berrington (A paper read at the Nottingham meeting of the British Assn of Water Engs. Treats of false ideas with regard to waste, quantity of water required, stop taps, &c). Plumb & Dec—Dec. 1. 2,000 w. 30 cts.

9773. The Water Supply of the Mutual Life Insurance Building, New York City (Illustrated description). Eng Rec—Dec. 12. 1,700 w. 15 cts.

9783. The Clinton, Mass., Dam (Describes the huge dam about to be built by the Metropolitan Water Commission of Boston. It will retain the largest amount of water ever stored in any reservoir, amounting to 65,000,000,000 gallons). Fire & Water—Dec. 12. 1,300 w. 15 cts.

9793. Test of the Canandaigua City Water Works. E. Hensen and C. M. Riker (Description of plant and of tests, which were made with the object of finding the efficiency of each part and the efficiency of the whole plant). Sib. Jour of Engng—Dec. 1,000 w. 30 cts.

9827. The Water Works of the City of Bale (Das Wasserwerk der Stadt Basel). A. Markus (A detailed account of the use of ground water as a source of supply, together with a description of the new gas motor plant of the Bale waterworks. Schw Bauz—Oct. 8 and 10. Both articles, 7,000 w.

9974. Chittagong Water Supply Project. E. G. Foy (Part first is a detailed account of the need of a plentiful supply of pure water, with suggestions for obtaining it, which are declared inadequate, and the investigations commenced by the writer). Ind Engng—Nov. 14, 1896. Serial. 1st part. 1,100 w. 45 cts.

10025. The Value of Rain Water Supplies for Domestic Use in Rural Districts in Ireland. Patrick Letters (The abundant rain fall and the possibility of securing the much needed water, which has thus far been disregarded). San Rec—Dec. 18, 1896. 1,300 w. 30 cts.

10102. A Hydraulic Ram Plant for a Public Water Supply (Illustrated description of the Rife engine and account of the installation at West Reading, Pa). Eng News—Dec. 31, 1896. 1,500 w. 15 cts.

10125. Capacity of Water Works Systems in American Cities (Data regarding the capacity of systems in cities of a population of 100,000 or more are given in part first. Munic Engng—Jan., 1897. Serial, 1st part. 600 w. 30 cts.

10189. The Water Works of Cambridge, Mass. L. M. Hastings (History and description, with illustrations. Followed by discussion). Jour New Eng Water Works Assn—Dec., 1896. 4,500 w. 75 cts.

10190. How to Secure Pure Water from a Surface Water Supply. John C. Haskell (Present details observed by the writer, with the effects that he thinks them likely to produce upon a surface water supply, giving both the experimental and philosophical sides of the question. Discussion follows). Jour New Eng Water Works Assn—Dec., 1896. 9,500 w. 75 cts.

10191. Utilizing a Spring as a Source of Water Supply for a Town. Louis E. Hawes (Discusses springs in general, their formation, and the possibility of utilizing them as a source of water supply. Gives data of two springs which been been used for town supplies). Jour New Eng Water Works—Dec., 1896. 6,300 w. 75 cts.

10192. Recent Specifications for Pumping Engines for the Water Works of the City of St. Louis, Mo. F. W. Dean (The specifications are given and discussed briefly). Jour New Eng Water Works—Dec., 1896. 10,000 w. 75 cts.

10212. On an Improvement in the Sedgwick-Rafter Method for the Microscopical Examination of Drinking Water. Daniel D. Jackson (The method of analysis is briefly described and the sources of error possible. Illustrated description is given of a new glass filter funnel constructed to obviate these errors). Tech Quar—Dec., 1896. 1,200 w. 75 cts.

10213. Experience with the Sedgwick-Rafter Method at the Biological Laboratory of the Boston Water Works. George O. Whipple (A study of the errors to determine the precision of the method as ordinarily used. The most important errors are noted). Tech Quar—Dec., 1896. 1,500 w. 75 cts.

MISCELLANY.

9758.—Municipal Playgrounds (Editorial comment on the movement of the population towards the city in both Europe and America, and the efforts being made to secure open spaces in the congested districts for the amusement and recreation of the children). Gar & For—Dec. 16. 1,100 w. 15 cts.

9850. The Bridge of the Exposition of 1900 (Note sur le Pont de l'Exposition de 1900). (A discussion of the disadvantages which further obstruction of the Seine would produce upon the river traffic on the Seine at Paris). La Révue Technique—Nov. 10, 1896. 2,500 w.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

9767. The Eaton Light Railway (Illustrated description of a line of very light construction on the Cheshire estate of the Duke of Westminster). Ry Wld—Dec. 1,000 w. 30 cts.

9845. The Operation of the Arlberg Railway (Die Betriebs-Ergebnisse der Arlbergbahn). Alfred Berg (A discussion of the expenses of construction and operation of this famous tunnel and road up to the end of 1895). Zeitschr d Oesterr Ing u Arch Vereines—Dec. 18, 1896. 1,200 w.

9985. The Kootenai Mining Country (An important railway enterprise looking to the development of this region). Ry Age—Dec. 18. 1,800 w. 15 cts.

10112. Railroad Building in 1896 (Tabular statement of lines building, new road, and the points between which the new track has been built, with editorial comment). RR Gaz—Jan. 1, 1897. 2,700 w. 15 cts.

10188. Great Northern Railway of Ceylon (Editorial review of what has been done so far and the various schemes for the future). Ind & East Eng—Dec. 5, 1896. 1,400 w. 45 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

9664. The New Heat Test for Car Wheels (Describes the methods of making heat tests used by the Pennsylvania Railroad, and by H. J. Small. Thinks these tests will furnish valuable information on the subject of wheels and wheel metals). RR Car Jour—Dec. 1,800 w. 15 cts.

9665. A Novel Design for a Combination Freight Car (Illustrated description of a novel design embodying the ideas of T. S. Easterbrook, of the Toledo, St. Louis and Kansas City RR). RR Car Jour—Dec. 800 w. 15 cts.

9764. Some Types of Light Railway Locomotives (Description, with drawings, of types of locomotives that have been successfully employed in Saxony and Belgium. Tabular statement of dimensions of types enumerated). Ry Wld—Dec. 1,100 w. 30 cts.

9786. Electric Train-Lighting on the Southeastern Railway (Brief remarks on improvements made in rolling stock, and general details of the train, and a description of the electric lighting gear). Elec Eng, Lond—Dec. 4. 1,400 w. 30 cts.

9839. The Korbuly Railway Journal Box (Korbuly's Achsenlager für Eisenbahnwagen). (Description and detailed drawings of a new journal box which has given excellent results on the Hungarian State Railways). Zeitsch d. Oesterr Ing u Arch Ver—Nov. 27, 1896. 1,000 w.

9926. Cast Steel in Locomotive Building (An abstract of papers and discussion at the Nov. Meeting of the New England RR. Club). RR Gaz—Dec. 18. 4,500 w. 15 cts.

9927. How to Bring the M. C. B. Standards Into Use (Letters from the members of a committee appointed to consider the question, read at meeting of the Central Ry. Club). RR Gaz—Dec. 18. 1,700 w. 15 cts.

9929. Tonnage Rating (Abstract of the report of Committee on "Recent Developments in the Tonnage System of Rating Locomotive Performance," as presented at meeting of Western Ry Club). RR Gaz —Dec. 18. 4,500 w. 15 cts.

9931. Car Ventilation (Editorial comment on the difficulties in securing good ventilation). R R Gaz—Dec. 18, 1896. 1,300 w. 15 cts.

9965. Electric Car Lighting in Austria (Summary of a paper, by W. Rayl, published in a recent number of the bulletin of the International Railway Congress. A satisfactory electric lighting equipment). Ry Rev—Dec. 19, 1896. 1400 w. 15 cts.

10055. New Ten-Wheel Freight Locomotives, Class "Q" Mexican Central Railroad (Illustrated detailed description of locomotive designed by F. W. Johnstone). R R Gaz—Dec. 25, 1896. 1600 w. 15 cts.

10076. The Proper Operation of, Care and Instructions Concerning Light Feed Lubricators (Report of Committee of Travelling Engs. Assn., on the modern and advanced styles of double and triple feed lubricators, with discussion following). Trav Engs Assn Rept—Sept., 1896. 10,000 w. 45 cts.

10077. Would the Rating of Engines by Tons, Instead of by Cars, Decrease Train Delays and Increase the Efficiency of the Power, and What Is the Best Method of Equalizing the Difference Between Empties and Loads? (Report of committee followed by discussion. The committee sent out a series of questions, and report the answers received). Trav Engs Assn Rept—Sept., 1896. 10,000 w. 45 cts.

10078. In What Way Can the Rough Handling of Trains by the Air Brake Be Reduced to a Minimum? (Discussion on correspondence of the Trav Engs Assn, with recommendations of the committee). Trav Engs Assn Rept—Sept., 1896. 13,500 w. 45 cts.

10080. Weakness and Failures of Side and End Freight Car Doors (Report of Committee of Southern and Southwestern Railway Club). Pro. of South & So-west Ry Club—Nov. 19, 1896. 6,800 w. 45 cts.

10108. Wide Vestibuled Passenger Cars (Illustrated description of cars recently equipped for the Lake Shore & Mich. So. Ry.). RR Gaz—Jan. 1, 1897. 250 w. 15 cts.

10109. Ten-Wheel Passenger Locomotive for the Lake Shore & Michigan Southern (Engraving and specification). RR Gaz—Jan. 1, 1897. 700 w. 15 cts.

10134. The Irish Railway and Its Locomotives. G. A. Sekon (Brief historical account of the Great Northern Railway of Ireland, and illustrated description of its modern locomotives). Mech Wld—Dec. 25, 1896. 1,600 w. 30 cts.

10169. Shall the Cubic Capacity of Ordinary Box Cars be Increased? H. H. Perkins (Read before the Central R. R. Club. Traces the growth in size and advises the associate roads to agree on a maximum size and refuse to handle or haul beyond that limit). Am Eng & RR Jour—Jan., 1897. 2,000 w. 30 cts.

10218. Passenger Locomotive for the Illinois Central Railroad (Illustrated description of engine just out of the shops of the Brooks Locomotive Works, which is considered to closely approach the highest development of the eight-wheeled type). Loc Engng—Jan., 1897. 1,300 w. 30 cts.

10267. Results of the Working of Two-Cylinder Compound Locomotives on American Railways. John H. Cooper (Presents in detail results obtained during the year 1896. The data relates exclusively to comparison of performances between two-cylinder compounds and simple engines when alike in every respect except the compounding devices, and working under similar conditions). Jour Fr Inst—Jan., 1897. 900 w. 45 cts.

10278. The New Water Scoop of the Pennsylvania Railroad (Illustrations showing general arrangement, with some details). RR Gaz—Jan. 8, 1897. 700 w. 15 cts.

10280. An Electric Switching Locomotive (Illustrated description, with dimensions, of an electric locomotive in constant service switching freight cars between the main line of the N. Y., N. H. & H. RR. and a number of factories located along the river front). RR Gaz—Jan. 8, 1897. 600 w. 15 cts.

MAINTENANCE OF WAY AND STRUCTURE.

9729. A Railway Bridge and Building Department. Onward Bates (Shows the importance of the work of this department, the changing conditions that must be met by engineers, with information and advice for young engineers). Purdue Soc of Civ Engs—1896. 10000 w. 45 cts.

9797. Large Bearing Surfaces for Rail Joints (Extract from a communication by C. P. Sandberg upon the advantages of large bearing surfaces). Ry Rev—Dec. 12. 1,400 w. 15 cts.

10054. The Effect of High Speed on Track Maintenance. P. H. Dudley (Reply to query of the R. R. Gaz. on this subject, showing that it has been an important factor in raising the standard of track, hastened the introduction of heavier rails, etc.). RR Gaz—Dec. 25, 1896. 800 w. 15 cts.

10175. Steel Sleepers (Discusses the causes of the absence of unanimity on the part of railway engineers respecting the merits and demerits of metallic sleepers. Shows that in certain places they cannot be used, a possibility of the effect upon high speed, and various disadvantages are mentioned). Eng Lond—Dec. 25, 1896. 2200 w. 30 cts.

10281. New York Central Track Elevation in Park avenue, New York (Brief, illustrated description of the changes which have been made in narrowing the viaduct, with outline of previous work). RR Gaz—Jan. 8, 1897. 1700 w. 15 cts.

SIGNALLING.

9696. Grand Trunk Signalling System at Toronto (Illustrated description of the manual system). Can Eng—Dec. 700 w. 15 cts.

9717. A Semaphore for Permissive Block Signalling (Illustrated description of a semaphore signal recently devised by the National Swith and Signal Co. for giving either a permissive or an all-clear go-ahead signal, while yet not using the intermediate position, as is done with the common three position semaphore). RR Gaz—Dec. 11. 900 w. 15 cts.

9738. Signalling Arrangements at Liverpool Street Station (Illustrated description. In the size of its yard, the complexity of its junctions and cross-overs, and the number of its daily traffic movements, this station probably now takes precedence of any other railway terminus in the world). Engng—Dec. 4. 7,000 w. 30 cts.

9759. Boult's System of Railway Signalling (Describes this invention of Wilfrid S. Boult, the underlying principle of which is the employment of a long magnetic field of transverse and reversible polarity on the road, and a special collecting armature and polarized relay or equivalent for closing a battery circuit, carried by the engine through this magnetic field). Prac Eng—Dec. 4. 5,000 w. 30 cts.

10092. The Signalling System of the Broadway and Seventh Avenue Railroad (Illustrated description). Sci Am—Jan. 2, 1897. 900 w. 15 cts.

10220. The Thomas Pneumatic Switch and Signal System (Illustrated description). Loc Engng—Jan., 1897. 1,400 w. 30 cts.

TERMINALS AND YARDS.

9838. The Great Train Yard at Dresden-Friedrichstadt (Der Grosse Rangirbahnhof in Dresden-Friedrichstadt). (An account of the new train yard at Dresden, with detailed description of the system of making up trains, &c.). Zeitschr d Oesterr Ing u Arch Vereines—Dec. 25, 1896. 1,000 w.

9986. Baltimore & Ohio Improvements (Rearrangements of tracks and yards at Pittsburg. Description with plans). Ry Age—Dec. 18. 1,000 w. 15 cts.

10104. New Terminal Station of the Canadian Pacific Ry. at Montreal (Plan showing the general arrangement of tracks, &c., at the new Dalhousie Square terminal station, with brief description). Eng News—Dec. 31, 1896. 500 w. 15 cts.

10107. The new Union Terminal Station at Boston (Description with plans of a station which will be the largest in the world, and possess features which are radically new). RR Gaz—Jan. 1, 1897. Serial. 1st part. 2,400 w. 15 cts.

TRANSPORTATION.

9709. Electric Motive Power. W. H. Weston (The writer thinks where heavy trains are to be run on distances greater than a few miles, steam power is far preferable. On hauls of a few miles, hauling but one or two cars, electricity or compressed air may be an efficient motive power). Baker's Ry Mag—Nov. 2000 w. 30 cts.

9718. Fast Trains in Continental Europe. J. Pearson Pattinson (Some particulars of the fastest third-class train in France, and some German express trains with very heavy loads behind the engine). RR Gaz—Dec. 11. 500 w. 15 cts.

10037. With the East Coast "Flyer." Charles Rous-Marten (Deals with the service, shows the locomotive performances to be excellent. Describes three runs in detail). Eng Lond—Dec. 18, 1896. 2500 w. 30 cts.

10069. Rail Transportation of Live Stock in Uruguay. Humphrey Chamberlain (From a paper presented to the Inst. of Civ. Engs., England. Descriptive). Ry Rev—Dec. 26, 1896. 1800 w. 15 cts.

10114. Passenger Train Service in France in 1896. P. Maury (Discussion in detail of recent improvements). RR Gaz—Jan. 1, 1897. 700 w. 15 cts.

10238. Some Changes in the Railroad Map. J. C. Ransom (Showing how consolidation and traffic arrangements affect transportation and build up southern ports). Tradesman—Jan. 1, 1897. 4500 w. 15 cts.

10283. The Traffic Field in 1896 (Annual review of the work, looking at some facts and incidents not touched upon by the Commission of Interstate Commerce). R R Gaz—Jan. 8, 1897. 1700 w. 15 cts.

10289. Recent Developments in Rating Locomotive Performances (An abstract of a paper read before the Western Ry Club by Mr. Tracy Lyon is given. The paper is divided under several headings, and under the same headings the practice of other railways is given for the purpose of comparison). Eng News—Jan. 7, 1897. 4,500 w. 15 cts.

10293. Current Transportation Topics. Emory R. Johnson (A discussion of various topics bearing upon transportation, such as the power of the Interstate Commerce Commission to fix rates, reorganization of traffic associations, railway receiverships, &c.). An Am Acad—Jan., 1897. 4,800 w. $1.

MISCELLANY.

9568. Railway Schemes in Parliament (A general editorial review of the possible work in prospect). Engng—Nov. 27. Serial. 1st part. 3,000 w. 30 cts.

9589. What Is a Water Brake? T. A. Hedendahl (Reply to the query). Loc Engng—Dec. 800 w. 30 cts.

9590. Water-Brake Cards, U. P. R. R. (The indicator diagrams given with description and explanation illustrate the force exerted in the cylinder as braking power, the distribution of that power throughout the stroke, and the variation of power due to the location of the reverse lever). Loc Engng—Dec. 400 w. 30 cts.

9635. Paints for Railways. M. F. Lindsay (Consideration of the necessities to produce a paint that will answer the purpose of a preservative of wood and iron). Ry Rev—Dec. 5. 2,800 w. 15 cts.

9636. Rail Top Culverts (Illustrated description of an excellent design of rail-top culvert which has proved itself to be satisfactory in service). Ry Rev—Dec. 5. 900 w. 15 cts.

9637. Interchangeable Mileage Tickets (Reprint of arguments as presented in this paper of June 4, 1892, which fairly state the case. Permission has been granted for such roads as desire to unite in the issue of such a ticket). Ry Rev—Dec. 5. 1,400 w. 15 cts.

9659. The Present and Future of American Railroads. Thomas F. Woodlock (Showing that railroads have reason to expect an increasing volume of business, and may reap a profit therefrom by avoiding waste in train mileage). Eng Mag—Jan. 4,800 w. 30 cts.

9666. Some Shop Tools (Illustrated description of a few special contrivances that are useful in railroad repair shops; tools, device for using compressed air, turntables, &c). R R Car Jour—Dec. 2,000 w. 15 cts.

9674. November's Poor Railroad Earnings (The returns the poorest for any month this year. Tables are given showing increase and decrease in each month, comparison of the month of November for the past three years, with gross earnings for November of different classes of roads). Bradstreet's—Dec. 12. 700 w. 15 cts.

9675. Little's Baltimore & Ohio Report (Mr. Stephen Little, the noted expert in railroad accounting, was employed to make an investigation of the company's financial affairs. The article comments on this report). Bradstreet's—Dec. 12. 1,100 w. 15 cts.

9681. A Wise Railroad Move (Account of a movement proposed by the Seaboard Air Line to establish 100 experimental farms along its line). Mfrs Rec—Dec. 11. 800 w. 15 cts.

9707. Economic Locomotive Management. George H. Baker (Part first deals with coal as the means of heat, and, therefore, the source of a locomotive's power. Reviews the origin of coal and the varieties). Baker's Ry Mag—Nov. 2,200 w. 30 cts.

9708. Lubrication. George L. Fowler (Lubricants and the ways of applying them are discussed. A brief review of what is known on the subject, and a few suggestions as to the considerations that should have weight in making selection of lubricants and bearing metals to be used on cars). Baker's Ry Mag—Nov. 4,000 w. 30 cts.

9710. Theory of Compound Curves in Railroad Engineering. Arnold Emch (The problem is treated from a general geometrical standpoint). Kansas Univ Qr—Oct. 1,400 w. 45 cts.

9716. Test of the Performance of a Locomotive Injector (A detailed description of the apparatus, the methods employed and some of the results that were obtained in a recent comparative test of locomotive injectors). R R Gaz—Dec. 11. 3,500 w. 15 cts.

9761. Japanese Railways. C. A. W. Pownall (Submitted to the last annual meeting of the Am. Roadmasters' Ass'n at Niagara Falls. An interesting description, with special reference to roadway and track construction). Ry Age—Dec. 11. 3,700 w. 15 cts.

9796. Coupler Knuckles (Gives the decision of the U. S. Circuit Court of Appeals in the case of Shickle, Harrison & Howard Iron Co. vs. St. Louis Car Coupler Co.). Ry Rev—Dec. 12. 2,600 w. 15 cts.

9798. Railway Schools (Facts from note by Mr. Messayedoff in the Bulletin of the International Ry Congress, describing the Russian schools). Ry Rev—Dec. 12. 1,600 w. 15 cts.

9844. The Derailment of the Scottish Express at Preston. (Die Entgleisung des Schottischen Expresszuges bei Preston.) H. v. Littow (An examination of the railway accident in Scotland on July 13, 1896, which in the author's opinion was due to too sharp a curve). Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Dec. 18, 1896.

9912. British Railway Statistics for 1895 (Statement relating to the capital, traffic, working expenditure and profits for the year). Eng News—Dec. 17. 1,000 w. 15 cts.

9930. The First London Railroad. W. B. Paley (Historical account of the London Greenwich Railway, the opening of which, as far as Deptford, was made 60 years ago). R R Gaz—Dec. 18, 1896. 1,200 w. 15 cts.

9966. Indicator Diagrams from Locomotive Schnectady. W. F. Goss (The engine named is mounted for testing purposes in the laboratory of Purdue Univ., La Fayette, Ind. Part first reviews briefly the precautions that were taken in securing the diagrams to be discussed). Ry Rev—Dec. 19, 1896. Serial. 1st part. 500 w. 15 cts.

9968. Tenth Annual Report of the Inter-State Commerce Commission (A brief reference to some of the subjects treated, with nine amendments to the law which are recommended). Ry Rev—Dec. 19, 1896. 1,800 w. 15 cts.

9971. The Slipping of Locomotives at High Speeds. C. E. Wolff (A series of careful experiments show that such a slip often takes place. The writer attempts to find some satisfactory explanation). Prac Eng—Dec. 11, 1896. 1,000 w. 30 cts.

10024. The Substitution of Electricity for Steam as a Motive Power for Suburban Traffic. John Findley Wallace (A paper intended to introduce the subject for discussion. Investigations made by the writer five years ago are given, with results. Concludes that electricity is more desirable for handling a large number of small transportation units at frequent intervals over short distances, and steam power for handling large units of transportation at high speeds, at infrequent intervals and over long distances). Am Soc of Civ Engs—Dec., 1896. 15,500 w. 45 cts.

10036. The Northeastern Railway Works (Full illustrated detailed description of the Gateshead Works, with drawings of Mr. Worsdell's latest engine). Eng Lond—Dec. 18, 1896. 9,300 w. 30 cts.

10050. Continuous Rails (Editorial discussion of the subject of "cast-molding," not favorable to the practice, especially in England). Elect'n—Dec. 18, 1896. 2,000 w. 30 cts.

10056. Annual Report of the Interstate Commerce Commission (Comment on the report, with brief extracts). R R Gaz—Dec. 25, 1896. 1,600 w. 15 cts.

10057. Train Accidents in the United States in November (Detailed list of the more important accidents, with classified summary.) R R Gaz—Dec. 25, 1896. 2,700. w. 15 cts.

10068. The Railway System of the Island of Java. A. Suethlage (Historical account, with particulars). Ry Rev—Dec. 26, 1896. 700 w. 15 cts.

10079. On Standard Form of Examination of Firemen for Promotion and New Men for Employment (Report of committee with discussion). Trav Engs' Assn Rept—Sept., 1896. 10,000 w. 45 cts.

10110. New Phases of the Connecticut Steam Trolley Contest. Clarence Deming (A statement of the proposed plan for meeting electric competition on its own ground). R R Gaz—Jan. 1, 1897. 2,500 w. 15 cts.

10113. Amendments to the Interstate Commerce Law (Editorial comment on the general good and harm of the act, with examination of the amendments). R R Gaz—Jan. 1, 1897. 1,800 w. 15 cts.

10137. Military Railways in War, Their Construction, Working and Defense. J. A. Ferrier (Lecture delivered at the Royal United Service Inst., Simla. Part first is introductory, with reference made to literature on the subject, comparison of camel power, classification, &c.). Ind Engng—Nov. 28, 1896. Serial. 1st part. 1,800 w. 45 cts.

10164. Receivership and Foreclosures in 1896 (The record for the year shows an increase in the number and mileage of roads placed in the hands of receivers, although the capitalization involved is less). Ry Age—Jan. 1, 1897. 800 w. 15 cts.

10167. An Automatic Indicator on the Western Railroad of France. M. E. Brille (An article translated, rewritten and condensed from a contribution to the "Revue Generale des Chemins de Fer" for Sept., 1896. Illustrated detailed description of apparatus). Am Eng & R R Jour—Jan. 1897. 2,200 w. 30 cts.

10183. Sunday Railway Traffic. L. S. Coffin (Pointing out the necessity for a rest day for railway men). Ry Rev—Jan. 2, 1897. 1,000 w. 15 cts.

10221. Hedley's "Puffing Billy" (Historical account of the invention of the first locomotive to haul cars profitably and to do the work expected, with general remarks). Loc Engng—Jan., 1897. 1,800 w. 30 cts.

10258. A Railroad Testing Laboratory. William O. Webber (Illustrated description of the Chicago, Burlington & Quincy R. R. laboratory at Aurora, Ill.). Mach—Jan., 1897. 1,200 w. 15 cts.

10279. The Teaching of Railroad Mechanical Engineering (Extracts from a paper by H. Wade Hibbard, read at Nov. meeting of the Northwest Railway Club. Presents a plan that has proved satisfactory in the Univ. of Minnesota). R R Gaz—Jan. 8, 1897. 1,400 w. 15 cts.

10282. The Railroads of India (Editorial review of condition as based upon the administration report). R R Gaz—Jan. 8, 1897. 1,200 w. 15 cts.

STREET AND ELECTRIC RAILWAYS.

9698. The Hamilton Radial Electric Railway. F. C. Armstrong (Brief account of a recently constructed system embodying features of approved practice). Can Eng—Dec. 1,200 w. 15 cts.

9753. The Glasgow District Subway

(Brief description, with map and sections). Eng Lond—Dec. 4. 1,400 w. 30 cts.

9765. Comparative Utility of Mechanical Tramway Systems (Summary of a paper by E. A. Ziffer, which was read before the International Tramways Union. Conclusions are based on investigations of contemporary tramway activity in Europe and America). Ry Wld—Dec. 1,000 w. 30 cts.

9766. Electric and Cable Traction in America (Notes on this subject from one who has looked on the developments in this field in America from the point of view of their applicability to British requirements). Ry Wld. Dec. 4,000 w. 30 cts.

9768. Fixed Stopping Stations on Tramways. C. Challenger (Discusses the advantages and disadvantages and gives the plan in vogue on the Bristol electric lines, which appears to give satisfaction). Ry Wld. Dec. 1,700 w. 30 cts.

9792. Test of Conduit Electric Railroad. H. G. Ogden, Jr., and F. W. Heitkamp (Abstract of a thesis presented for the degree of M. E. Briefly describes the Metropolitan Electric Street Railroad of Washington, D. C., and gives summary of plant test and line tests). Sib Jour of Engng—Dec. 1,300 w. 30 cts.

9794. Test of an Electric R. R. Power Station. F. W. Phisterer (A statement of what such a test consists and what may fairly be expected in such work in the way of difficulties and arrangements). Sib Jour of Engng—Dec. 2,400 w. 30 cts.

9799. The Underground Trolley and the Third Rail in Electric Traction (Comment on the proposed further application of electricity on the N. Y., N. H. & H. R. R., and the proposed installation of the Metropolitan Traction Co., of N. Y.). Sci Am—Dec. 19. 1,000 w. 15 cts.

9923. Notes on the Electric Railway Return. G. W. Knox (Read before the Chicago Elec. Assn. Considers the plans of having a metallic return made up by heavily bonding the rails and using a supplementary wire in connection therewith, and the joining the rails in such a manner as to secure the full value of their current conducting capacity). St Ry Rev—Dec. 15. 5,000 w. 30 cts.

9924. The "Cast-Weld" Joint as a Conductor. Harold P. Brown (Illustrated description of joints and tests made, with results). St Ry Rev—Dec. 15. 1,400 w. 30 cts.

9925. The Misuse of Sand. H. S. Cooper (Discussing how it shall be applied to the rails). St Ry Rev—Dec 15. 1,800 w. 30 cts.

10012. Electric Traction in the United States in 1896 (Report of Messrs. Young and Clark to the Tramways Committee of Glasgow on the principal tramway enterprises in North America. A brief notice of some of the larger systems inspected during their visit to America). Elec Lond—Dec. 18, 1896. 2,500 w. 30 cts.

10059. Cast-Welded Rail Joints. William Baxter, Jr. (Comment on the ideas brought out in M. K. Bowen's paper, with a few extracts). R R Gaz—Dec. 25, 1896. 2,000 w. 15 cts.

10060. Track and Track Joints. Construction, Maintenance and Bonding. M. K. Bowen (Read before the Am. St. Ry. Assn. at St. Louis. Discussion of how to construct and maintain a street railway track, giving special attention to the advantage of having welded joints. Discussion). Elect'n—Dec. 18, 1896. 4,500 w. 30 cts.

10084. The Richmond Traction Co.'s Railway System (Illustrated detailed description). Elec Eng—Dec. 30, 1896. 1,200 w. 15 cts.

10193. The System of the Washington, Alexandria and Mt. Vernon Railway (Illustrated detailed description). St Ry Jour—Jan., 1897. 3,800 w. 45 cts.

10194. The Plant of the Toledo Traction Company (An illustrated account of the extensive system owned and operated by this company, and of other business controlled by them). St Ry Jour—Jan., 1897. 2,000 w. 45 cts.

10195. The Street Railway System of Paris. M. Lavalard (Part first briefly reviews the history and growth and the progress of mechanical traction). St Ry Jour—Jan., 1897. Serial. 1st part. 900 w. 45 cts.

10196. Electric Railway Power Stations in America and the Economic Results of Their Operation. L. D. Tandy (A table gives in detail the operation of a number of stations of various types, including the triple expansion and compound engines, direct connected and belt driven generators, condensing and non-condensing. Also a table of percentage comparison of stations, with additional information). St Ry Jour—Jan., 1897. 1,700 w. 45 cts.

10197. Some British Impressions of American Street Railways. Alexander McCallum (The comments are generally favorable). St. Ry Jour—Jan., 1897. 2,500 w. 45 cts.

10198. The Development of the Modern Electric Railway Car Wheel. P. H. Griffin (The effect of local regulations concerning form of rails, &c., is shown, and the service, material and design discussed). St Ry Jour—Jan., 1897. 1,700 w. 45 cts.

BOOKS OF THE MONTH

BELL, LOUIS, PH.D. POWER DISTRIBUTION FOR ELECTRIC Railroads. Street Railway Company, New York. 1897. Cloth, $2.50, postage prepaid.

The purpose of this book has been to place in the hands of those daily concerned in transportation by electric traction a serviceable treatise in which not only general principles are set forth, but in which, also, are presented descriptions of ways whereby methods can be coördinated with principles in every-day practice. In his preface the author disclaims anything like an exhaustive treatise; the aim has been, rather, to make it suggestive. The rapid changes in apparatus would, indeed, have precluded an exhaustive attention to details. The volume contains nine chapters, and the style is clear and concise. The first chapter deals with fundamental principles. Chapter II discusses the return circuit with the practical points which must be met in a successful system. This is followed by a chapter on direct-feeding systems, and another on special systems of distribution. In Chapter V auxiliary sub-stations with power transmission, distributed stations, and cost of power as related to auxiliary stations are presented in a plain, easily-understood way. Chapters VII, VIII, and IX are devoted, respectively, to the different varieties of alternating motors for railway work, to inter-urban and cross-country work, and to fast and heavy railway service. The impression gained from a cursory survey of the contents is that the treatise is the work of an alert, bright, and experienced engineer well up to date in his facts and observations. The illustrations are profuse, a large proportion of them being half-tones.

CARTER, E. TREMLETT, C. E. MOTIVE POWER AND Gearing for Electrical Machinery. A Treatise on the Theory and Practice of the Mechanical Equipment of Power Stations for Electric Supply and for Electric Traction. The D. Van Nostrand Co., New York. 1896. Cloth, $5.

"An account of the scientific principles and modern practice in the use of engines for driving dynamos" is, so we are told in the preface, the design of the work, "to be clothed in as simple language as would be consistent with accurate and complete treatment." Accuracy and completeness being thus made paramount, the value of the book must be measured by these standards, and it will not suffer by their most rigorous application. Its comprehensiveness is manifested by its copious index, occupying twelve full double-column pages. The book contains 608 pages, of which 490 are occupied with power generation. Four pages relating to water-power testing follow, and pages 493 to 550, inclusive, deal with the various modes of connecting prime motors with dynamos. This is followed by examples of power stations for electric supply and electric traction (pages 551 to 581, inclusive), and pages 582 to 608 are occupied with appendices (A to G, inclusive), which comprise a table of properties of dry saturated steam; note on Druitt Halpin's system of thermal storage, and an analysis of sundry electric-supply station accounts.

The book is well printed from clear, bold type, and is well illustrated. It is a volume that should find a place in the library of every mechanical engineer.

BOOKS RECEIVED.

Lowe, Joseph G., Simpson, J. M., and Howe, Samuel T. (Railroad Commissioners). Fourteenth Annual Report of the Board of Railroad Commissioners of the State of Kansas for the year ending November 30, 1896. The Kansas State Printing Company, Topeka, Kansas. 1896. Cloth.

Report of the United States Commissioner of Education for the year 1894–1895, Vol. 1, Part I. Government Printing Office, Washington, D. C. 1896.

Seventeenth Annual Report of the United States Geological Survey. 1895–96, Part III (continued). Mineral Resources of the United States, 1895. Non-metallic Products, except Coal. Government Printing Office, Washington, D. C. 1896. Cloth.

Seventeenth Annual Report of the United States Geological Survey 1895–96. Part III. Mineral Resources of the United States. 1895. Metallic Products and Coal. Government Printing Office, Washington, D. C. 1896. Cloth.

Building and Engineering Trade Directory for 1896–'97. F. W. Dodge, Boston. Cloth, $2

Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. Vol. X. 1894–95. Edited by the secretary. Democrat Printing Co., State Printer, Madison, Wis. Paper.

BOOKS ANNOUNCED.

Andrews, T. Thermo-Electric Reactions and Currents Between Metals in Fused Salts. Spon & Chamberlain, New York. 1896. Paper, 40c.

Bedell, F. The Principles of the Transformer. D. Van Nostrand Co., New York. 1895. Cloth, $3.25.

Bushell, S. W., M. D. Oriental Ceramic Art. Illustrated by examples from the collection of W. T. Walters, with 115 plates in colors and over 400 reproductions in black and white, with text and notes. Appleton, N. Y. 1896. Ten sections, each with forty plates and in leather portfolio. Edition limited to five hundred copies. Subscription price for complete work, $500.

Frith, H. and Rawson, Stepney. Coil and Current, or, The Triumphs of Electricity. Ward, Lock & Co., New York. 1896. Cloth, $1.25.

Houston, Edwin J., and Kennelly, Arthur Edwin. (*a*) The Electric Motor, (*b*) Electric Telegraphy; (*c*) Electric Telephony; (*d*) Electric Street Railways. The W. J. Johnston Co., New York. 1896. Uniform cloth, each $1.

The Mechanics' Lien Law of the State of New York (Passed May 27, 1885). Revised and enlarged with all the amendments, and applicable to the entire State; also the lien laws as to municipal property in incorporated cities, railroads, oil-wells, etc., With notes of judicial decisions, and a full collection of forms compiled by W. L. Snyder. Third edition. Baker, Voorhis & Co., New York. 1896. Half sheep, $3.

Sharp, Archibald. Bicycles and Tricycles. An elementary treatise on their design and construction, with examples and tables. Longmans, Green & Co., New York. 1896. Cloth, $4.

Hopkins, W. Rowland. The Street Railway Problem in Cleveland. A Statement of Existing Conditions and the Policy Which the City Should Pursue with Regard to its Street Railways. The Macmillan Co., New York. 1896. Paper, 75c.

Perkins, C. A. Outlines of Electricity and Magnetism. M. Holt & Co., New York. 1896. Cloth, $1.10.

Miller, J. H. (of the San Francisco Bar). Dredging on the Pacific coast. Illustrated description of various dredging machines, and comparisons of their performance. John H. Miller, San Francisco. 1896. Paper.

Coleman, T. E. Sanitary House Drainage: Its Principles and Practice. A Handbook for Architects, Engineers, and Builders. Spon & Chamberlain, New York. 1896. Cloth. $2.

Cooper, J. H. A Treatise on the Use of Belting for the Transmission of Power. New issue. Fourth edition. D. McKay, Philadelphia, Pa. Cloth, $3.

Kapp, Gisbert. Transformers for Single and Multiphase Currents. A Treatise on their Theory, Construction, and Use. Translated from the German by the author. The Macmillan Co., New York. 1896. Cloth, $1.75.

Meadowcraft, W. H. A B C of Electricity. New Issue. American Technical Book Co. New York. 1896. Cloth, 50c.

Poor, H. V. Poor's Manual of Railroads of The United States for 1896. H. V. & H. W. Poor, New York. 1896. Cloth, $7.50.

Ramsey, W. The Gases of the Atmosphere. The History of Their Discovery. The Macmillan Co., New York. 1896. Cloth, $2.

Robinson, H. Sewage and Sewage Disposal. Spon & Chamberlain, New York. 1896. Cloth, $4.50.

Rothwell, R P. The Mineral Industry: Its Statistics, Technology, and Trade in the United States and Other Countries, from the Earliest Times to the End of 1895. The Scientific Publishing Co., New York. 1896. Cloth, $5.

Thompson, Sylvanus Phillips. Polyphase Electric Currents, and Alternate Current Motors. American Technical Book Co., New York, 1896. Cloth, $2.75.

Roper, Stephen. Simple Process for Estimating the Horse-power of Steam Engines from Indicator Diagrams. New issue. D. McKay, Philadelphia. 1896. Cloth, 50 cents.

Roper, Stephen. Use and Abuse of the Steam Boiler. New issue. D. McKay, Philadelphia. 1896. Morocco, $2.

Roper, Stephen Young Engineers' Own Book. Principles and Theories of the Steam Engine as a Prime Mover. D. McKay, Philadelphia. 1896. Morocco, $3.

Saward, B. C. Decorative Painting. A Practical Handbook. Charles Scribner's Sons. New York. 1896. Cloth, $1.25.

Jackson, C. F. Mechanical Drawing. J. B. Lippincott Co., Philadelphia. 1896. Buckram, $1.50.

Kittredge, G. W. The New Metal-Worker Pattern Book. A Treatise on the Principles and Practice of Pattern Cutting as Applied to Sheet Metal Work. D. Williams, New York. 1896. Cloth, $5.

McNeill, T. E. Steam and Hot Water Fitters' Text-Book. D. Williams, New York. 1896. Cloth, $1.

Practical Gas-Fitting. Reprint from The Metal Worker. D. Williams, New York. 1896. Cloth, $1.

Norris, W. A Practical Treatise on the "Otto" Cycle Gas Engine. Longmans, Green & Co., New York. 1896. Cloth, $3.

Shaler, N. S. American Highways. A Popular Account of Their Conditions and of the Means by which they may be Bettered. The Century Co., New York. 1896. Cloth, $1.50.

Thresh, J. C. Water and Water Supplies. Imported by W. B. Saunders, Philadelphia. 1896. Cloth, $2.25.

Trowbridge, J. What is Electricity? D. Appleton & Co., New York. 1896. International Scientific Series, No. 75. Cloth, $1.50.

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THE FINANCIAL MEASURES NEEDFUL TO INDUSTRIAL STABILITY.

By James H. Eckels.

ONE of the hopeful signs of the times, and one which, indeed, is, in a measure, a direct legacy of good from an era which has often seemed almost wholly bad, is the awakening interest of the industrial world in the great questions of financial policy, and the growing demand that financial and tariff legislation shall be settled upon principles of sound wisdom and national stability.

The rapid increase in wealth, and the absorption of our people as a class in the exacting pursuits of trade, commerce, or industry, have left the conduct of the government so largely to the politician, and dissociated it so widely from the life of the ordinary citizen, that we almost forget that ours is a government not only of the people, but by and for the people. But business and professional men are awakening to a realization that this dissociation is no longer possible. They cannot remain absorbed in the erection of the great structures of successful enterprise, while the law-maker is shaking the very foundations beneath by swaying the finance and credit of the nation at the impulse of party platforms or private pressure.

And no one is more vitally interested in the maintenance of financial stability than the engineer, for the capital whose employment and direction is his life-work will not venture forth when the national credit is insecure and the national policy uncertain.

It was the appreciation of this that led THE ENGINEERING MAGAZINE to press these national questions to the front throughout the recent period of agitation. The *Railroad Gazette* throws its influence for sound money, because the railroads realize that a free-silver policy would mean universal bankruptcy. The *Engineering News* finds space for financial discussions, while a mining review debates the money question, and an electrical journal proposes free banking instead of free silver.

The best evidence that the whole financial system of the country is radically wrong is to be found in the fact that it is continually a subject of discussion and debate. All the depression in business circles which has been witnessed within the past few years is not to be charged to its defects, nor will the remedying of them insure the people against many losses in the future. There is no legislation which can be devised and put into operation which will prevent disastrous results following a disregard of the requisite rules of business sagacity. It is impossible that there shall be general accumulation where there is general extravagance, and bankruptcy is inevitable where, for a long series of years, there has been a steady expenditure beyond the income received. Over-trading, undue extension of credit, and unwarranted speculation can end only in ruin more or less widespread.

A general survey of the course pursued by the American people throughout the past ten years will show how very much causes, for which they alone are responsible, have contributed to produce the conditions of which they complain. No one, at the beginning of the liquidation of 1893, realized how prolonged would be the course it would run, or how extensive would be its sweep. It seemed not to have been known how very much capital and credit had been embarked in wild enterprises, having as a basis unwarranted expectation of profits. With each succeeding year since that time the public have become more intimately acquainted with the extent to which "booms" in cities and villages were developed during a period of flush times. If, at the time, it was not suspected that the undertaking being fostered was at all out of the range of the legitimate, or its capitalization in excess of an amount upon which a certain profit could be returned to the investor, that fact has since been made apparent. The surprising thing about it all, now that it is approaching an end, is not that so much wreckage has resulted, but so little. The total of the loss to individuals and corporations is only partially known to the public. Its knowledge is confined to the court records of assignments. It is wholly unacquainted with the shrinkage in values where complete bankruptcy has been averted, losses charged off without producing failure, and the assessments paid in order to repair capital and continue in business.

At the end of such a period, when the hope is general that improved conditions are to come and liquidation cease, the time is opportune for such action as will certainly lessen the liability of a return of the experience through which we have passed. Added to the things enumerated as contributing causes of loss to the people must be the unwholesome effects of our monetary laws. Within the life of the administration just closing, one of the worst of monetary acts was taken from the statute-book. Others, however, remain, and, until a complete change is wrought in them, the country can never be entirely free from recurring danger. It is no part of the duty of the country's law-makers to enact or maintain legislation which makes the general government a partner in every citizen's private business undertaking, whether that legislation operates through a tariff system or through a financial one. In either case, to the extent that such legislation is put in operation, are introduced uncertainty, doubt, and, ultimately, danger, if not disaster. The source of much of the speculation of recent years developing panic and bankruptcy is directly traceable to legislation which created an artificial prosperity for a brief period. The general good of the country demands that the people be free in the future from law-made periods of prosperity ending in disaster, and that patent defects in existing enactments be remedied.

The result of the recent election was an emphatic declaration that our citizens want the best monetary legislation. As between the silver standard, carrying with it a debased currency, and the gold standard, expressing itself in a money of unchanging value, they have declared for the latter. The effect of doubt upon the subject as to just what was the view of the majority of the voters long worked harm to every business interest of the country, and added to the difficulties of the government. The government has persisted in following a policy of direct note issues by the treasury which more than once prior to 1893 had been a source of embarrassment to it and of weakness to the commercial world. That the danger from such issues was scarcely noticeable for some years after the resumption of specie payment in 1879 was only because time was necessary to develop the evils of other legislation affecting our monetary conditions. It took time to prove how burdensome was the enactment providing for the current redemption and the compulsory reissue of the legal tenders. The accruing loss through the coinage of silver under the provisions of the Bland-Allison act did not manifest itself until many silver dollars had been sent from the mint. Though the disastrous consequences of the Sherman law were known to the financial world from the first, the general public did not note such fact until two years had elapsed. Each of these ill-advised legislative financial palliatives weakened the resources of the government, injured its credit, and deranged the country's trade and commercial relations. The joint effect of all was to call attention to the large amount of credit currency the government was attempting to carry, and the limited resources possessed by it to meet its full responsibility.

By statute it is declared to be the established policy of the government of the United States to maintain at a parity the various forms of money in circulation. Its ability to do so was strengthened by the repeal of the Bland-Allison act and the Sherman law. The full measure of relief will not be reached, however, until other steps are taken. These other steps are to provide for the redemption in gold of the legal-tender demand obligations of the treasury, to cancel them, and thereafter to refrain from entering into competition with the banks in the field of bank note issuing. Recent events have proven how extremely expensive the maintenance of these treasury notes is when doubt as to the ability of the treasury to redeem them in gold is even hinted at. The argument cannot be successfully advanced that it is unnecessary, now that the treasury is not being pressed for their redemption, to make them a subject of legislation. It has been already demonstrated that they are a cancerous growth, full of danger. The wisdom of the situation is to take effective measures for complete relief, through means known to be curative, instead of trusting to chance or time. If, again, the country is thrown into the distresses of panic and business disturbance, a quicker and larger resort will be had to these treasury issues in order to obtain gold for hoarding purposes, for all now understand the use of them. At one time, it may truthfully be said, many considered the government's treasury issues as one of its assets, instead of a liability. That day has gone, and everyone now realizes that not only are they not a source of wealth, but are, instead, a source of expense, loss, and uncertainty.

Provision for the payment of these obligations would be justified on the grounds that a danger to business undertakings would be thus removed, a continuing and increasing expense brought to a definite close, and the largest cause of a periodical want of confidence in the solvency of the treasury done away with. The failure to deal with them cannot be justified on any grounds. Legislation looking to this end must be had if the treasury department is to be rid of a difficulty more troublesome than a mere deficit in the revenues. It must either precede, or be embodied in, any banking legislation undertaken. If not made a distinct measure, it must find solution through a banking and currency act. Once rid of this trouble, some banking code could be enacted which would properly meet the demands of trade and commerce. The revision of the bank act, leaving the treasury still embarrassed and the secretary of the treasury powerless to meet the duties imposed upon him, would simply mean remedying an inconvenience and stopping a small loss, while doing nothing to cure a deep-seated disease entailing the possibilities of complete destruction. Ultimately banks, guarded by safe restrictions, will be able, through issuing against bankable assets bank notes redeemable in gold on demand, to adequately supply the country with a currency sufficient for all purposes. They ought to supply all the credit currency issued, and they ought to be required to redeem it all in gold, thus shifting the responsibility for gold payments from the government to the banks, where it properly belongs. They should be given power to establish branches, and thus supply places now deprived of banking facilities with loanable capital and the means of obtaining credit. It is the province of banking institutions to meet the needs of the business world, and, in the doing of the things essential to the purpose for which they were created, they ought not to be unnecessarily hampered by the government or brought into competition with the government. Under existing laws banks to-day have their note-issues in direct competition with those of the government, while their deposits are lessened, and the amount of currency needed in daily business is curtailed, by the sub-treasury system. Whatever may have been the reasons for the excessive tax upon note-issues, and for the limitations placed upon their volume and the manner of issue, at the establishing of the system, they do not now exist. So, too, with the sub-treasury system. It is wrong in theory and hurtful in practice. It does not make the funds of the government more secure to it than other means of handling them would, and it does work, at times, great loss and hardship to the business world, because it needlessly withdraws large sums of money from the channels of trade to lie idle in the sub-treasury vaults.

In general, it may be said that the financial interests of the people will best be subserved by legislation providing for the payment in gold and cancellation of the treasury issues now outstanding whenever in the future they may be presented for redemption; giving to the secretary of the treasury adequate and unquestioned powers to protect the credit of the government at any and all times; granting to the banks enlarged powers of note-issue upon lines of public safety under proper supervision, designed to meet the commercial necessities of all sections, making them solely responsible for the redemption of the same in gold; and so modifying the sub-treasury system as to make it a public benefit instead of a business hindrance.

It may be argued that all this tends to place too much power in the banks. These questions cannot be properly determined, if they are to find solution only through alleged prejudice against institutions equipped with all the machinery necessary to meet the daily demands of business. Elsewhere banks, instead of treasury departments, issue and redeem all the promissory notes which circulate as currency. Why not here? Elsewhere banks finance the affairs of the governments with which they have to do, without loss to such governments and without prejudicing the rights or jeopardizing the liberties of the people. Why not here? It is hardly to the credit of the people of this country that they insist on dealing with business questions from every standpoint save a business one. If other people, boasting less publicly of advance in the commercial world and of enlightened views on matters of public moment, can deal with banks as institutions productive of general good and as an aid to individual prosperity, Americans ought not to fall behind. When the people fully realize that the prosperity of the banks of the country but reflects the prosperity of the communities where they are located, less will be heard upon the platform, on the stump, and in legislative halls of their general destructiveness of the public welfare. As long as needed legislation affecting them and affecting the government's financial affairs is to be denied through, or molded by, party political necessities, exaggerated prejudices, and subservient cowardice, trade and commerce must suffer, labor be denied employment, and prosperity languish.

It is essential, therefore, that engineers, business managers, and men of affairs generally should realize the influence which may be wielded by personal letters to the members of congress, bringing the legislative bodies into fuller appreciation of the vital interests of industry and trade. Everyone whose life-work and direct contact with these questions enables him to see clearly the situation and its needs, should make it a duty to address his representative individually.

The effect of such communications, evidently born of accurate knowledge and profound conviction, will be of inestimable benefit, and will produce a public sentiment which no legislator will wish to set at defiance.

MISTAKES AND IMPROVEMENTS IN RAILROAD CONSTRUCTION.

By George H. Paine.

WHEN we trace the development of railways from their inception, one thing strikes us forcibly and immediately; carriages and locomotives made up to about the year 1840, no matter where, looked much alike, but those of later date, under the influence of certain tendencies, were more and more differentiated, until in 1850 the individuality of the rolling-stock of different lands became pronounced.

At present the American railway coach and its British relative no more appear to be designed for the same purpose than do a toy terrier and a St. Bernard seem to belong to the species *canis familiaris*. The differences consist not only in dimensions and internal arrangements, but in external finish and appearance.

Why this should have been so, what it signifies, where it has led us, and whither it is leading us will be the theme of this paper.

In making comparisons, English railway practice is used to set off American, since, although we belong to the same mixed race, there are fundamental differences of character that have caused us to adopt different methods in almost all matters of procedure. So truly have we followed our national tendency that to-day there is less resemblance between English and American railway track and equipment than between those of America and Germany. In England we find much resemblance between the early and recent types of cars and locomotives; the track also, in a large measure, has followed the same general conservative tendency, increasing in strength and dimensions as the demands due to higher speeds and heavier motive power required, but preserving in a remarkable manner the original ideas. In the United States the national characteristics have shown active influence both in line and equipment. The locomotives and cars are in every way different from the original types, except that they are propelled by steam and run on wheels, while the track itself has now little resemblance to early forms.

The conservatism with which the older countries, particularly England, entered upon the construction of railways stands in violent contrast with the enthusiasm displayed in the United States, where lines were built up hill and down dale; if a straight line was convenient, it was used; if not, we put in a curve; and, if an easy curve was inconvenient, we put in a sharp one.

Our national habit of "hitching our wagon to a star" and then "letting her go" was well exemplified in this matter. In Great Britain the mere granting of a charter was preceded by solemn and impressive rites. Parliament discussed it, committees sat upon it, witnesses were summoned, sworn, and questioned even to the butcher (literally) and probably to the baker and candlestick-maker. Engineers and others were examined as to the dangers attending the use of inclined planes (grades), and it was seriously and widely stated that a grade with an inclination of 1 per cent. (53 feet per mile) or a curve with a radius of three fourths of a mile (about a 1½-degree curve) were respectively as steep and as sharp as was consistent even with moderate safety when the terrific speed of their main-line trains was contemplated; sometimes, it must be remembered, they ran at an average rate of twenty-three miles an hour.

An excerpt from the abstract of evidence given before parliamentary committees in 1832 in the matter of an application to build a railway between London and Birmingham shows better than anything else the solid and rational method adopted by the authorities to ascertain whether or not the road was really needed for the public benefit, and, if so, to make it sure that the proposed line was the best for the purpose.

In the first place, the civil engineers testified to the cost, character, and physical peculiarities of the route. Here are a few of the details as given by Robert Stephenson, great son of a great father.

Twenty-two turnpike bridges: fifty-five parish-road bridges; one hundred and twenty inferior-road (highways of little use) bridges, and (think of it, oh, ye railroad builders of the year 1897!) two hundred private-road bridges,—in other words, farm crossings: all of this in the year 1832. The steepest grade was fifteen feet per mile; the sharpest curve appears to have had a radius of 4,000 feet; the ballast was of broken red sandstone, gravel, or chalk (on another line of the same period the ballast was laid twenty-one inches thick); the slopes varied from ¾ to 1 in chalk to 2 to 1 in clay and loose earth.

After the engineers had testified, landowners, farmers, hostlers, merchants, carriers, clerks in the stamp office, butchers, ship brokers, manufacturers, grocers, and, in fact, representatives of nearly every trade and industry, were called in to give evidence as to the necessity of the proposed line. Then, when the whole question had been canvassed; when the engineers had been made to prove that theirs was not only the most feasible, but a safe, line; when the directors had shown by their witnesses an actual business reason for its existence,—then and not until then was the construction authorized and the public encouraged to invest. For not only did parliament think it best that no private rights should be violated in any form, but they also considered it their duty to see that no wild-cat schemes should operate so long as they could be prevented.

We have laughed and sneered at John Bull's dulness so much; it has so long been the fashion for his American cousins to think of him as an old fogy,—that it is now regarded by many as unpatriotic to say a word in appreciation of him; but let us see how we stand at the present time as compared to early English practice.

In at least one of the United States it is required by law that a certain proportion each year of the grade highway crossings on all railways be converted to either over-head or sub-grade crossings, while on many railways outside that State every effort is being made in the same direction through the initiative of the railways themselves. What has been saved to the English railways by this hard and fast rule in a total avoidance of claims for damages incurred at highway grade crossings and in lessening the necessity of watchmen, it is impossible to say; but it must be an immense sum, and quite equaled by the benefits which the public themselves have received. Some notion of the moral aspects may be gathered from the reports of the interstate commerce commission, the last of which says that in 1895 five hundred and eight persons were killed and nine hundred and sixty-one persons more or less injured at highway crossings by railway trains. Of this number not one was employed by the railway company, and all therefore, were, to that extent, innocent and unnecessary victims.

In another particular a great change has come over our practice within the past few years; this is in the matter of crossings between railway lines at grade. Whereas, in England, it was forbidden from the very start, (whether between the tracks of separate companies or between two intersecting tracks of the same company) we in this country seem not even to have considered the question, let alone tried to prevent the error.

At present, we find that, in some comparatively rare and noble instances, the railways themselves oppose the practice on principle and are willing to undergo a considerable and voluntary expense to prevent so criminal an arrangement; but, in the vast majority of cases, the dangerous feature is ignored and the fight, which nearly always occurs, is over the question which shall pay the watchman.

The general public, who must in one form or another ultimately pay the piper, are totally indifferent since, except for a small minority, they do not know that such a thing as a grade crossing exists.

The danger, which must always be present in a greater or less degree when railways cross each other at grade, has been partly met in some states by requiring that interlocked signals shall be installed at all new crossings which may hereafter be formed. In a few states there are also certain laws which provide for the interlocking of previously existing crossings, under conditions, however, which are so vague that very little advance has been made except through the efforts of the railways themselves.

That interlocking is an immense advantage, is well known now and widely appreciated but where grade crossings are concerned it is merely begging the question, since the crossings themselves are an anachronism.

Even in 1832 the relations that existed between grades and the cost of hauling trains were carefully analyzed, and calculations were made by English engineers tending to show the cumulative cost of transportation on grades, and how it is that a more expensive, but more level, line will be cheaper and more convenient in the course of time. In consequence of this old fogyism (?), we to-day see the English railways operated over the original road-bed as it was originally laid out. It is known, of course, and appreciated that the cost of transportation per ton per mile in Great Britain is much higher than in this country; but this excess is largely due to their short average haul and to some other causes,—notably their complete arrangements for signalling trains, a sacrifice in economy made to and demanded by the public in the interests of safety. But, even though these two items do not account for all of the increased expense, it is a plain and simple proposition that, by reason of the superior physical conditions surrounding British railways,—conditions established when they were first constructed and therefore at the proper time and with the least expense,—it is a much easier matter for them to reach their ultimate economy in operation than for railways as a class in this country. We have some splendid examples of location, but how often we find long lines through an easy country which must be largely rebuilt in order to compete on even terms with other more intelligently constructed roads!

It is not a sufficient answer to the foregoing to say that in this country the population was too sparse, the amount of money too small, and the rates of interest too high to warrant the construction of such lines as have been described. In some cases, railways built in an ignorant manner have been able to make a living, and eventually to save enough money to pay for their reconstruction; but this is not the rule, and isolated instances, when contrary to the general experience, do not constitute proof; while it seems moderately sure that the few roads which have been able to survive under these adverse conditions, would have been better off always, had they been properly constructed in the beginning.

A great deal is said regarding the benefits to the country at large that have followed the construction of railroads; but these benefits have been secured, in most cases, by immense individual losses. In these sacrifices and the inability of the stockholders to stand any further financial strain, we find one reason for the present physical characteristics and apparent tendencies of our railroads.

We unfortunately have no great court of last resort in the form of a well-digested public opinion to turn to or depend upon in matters which affect the individual. Examinations into the cause of a "ten-killed tail-ender" are usually left to the intelligent research of a rural coroner's jury, which ends by censuring the poor devil of a flagman who did not go back far enough.

The truth of the matter seems to be that when the legislatures first chartered the railways, and for many years afterward, nothing was expected or required of the railways in return, which was at all commensurate with the privileges they received. The right of eminent domain was an immense power and should have carried with it a responsibility to the people which is only now beginning to secure recognition.

That this recognition sometimes manifests itself in an ignorant and dangerous manner is not surprising, nor the fault of the railways so much as it is of the people themselves. Who shall say that a company asking for a charter must refuse to accept any concessions which are offered by the grantor? But, nevertheless, an agreement which is unfair is neither good law nor good sense, and a careful authoritative supervision over our railways from the start would have been better for them, and better for the public, than are the present blind and tentative efforts to recover a control which ought never to have been surrendered.

It is not denied that to speak of government control is as a stench in the nostrils of many good citizens and comes perilously near the phrase "government ownership."

But why start at a phrase? The installation of various state railway commissions, the continued existence of the interstate commerce commission, the frequent enlargements of their functions, prove that it is to a limited control we are tending.

The method of investigation followed by the authorities in the London and Birmingham matter, as outlined in the first part of this article, was slow but sure, and, by making haste slowly, they were saved from many costly mistakes. Have they had cause to regret their deliberation? It appears not.

Like the man who decides to economize, and starts by refusing to pay his debts, we have begun at the wrong end ; and so we must sweat it out. In fact, we have been sweating it out for the last five years, and a good deal of impure matter has been expelled.

If the general good of the country required that unprofitable lines should be built, better results would have been secured by making it a matter of general expense by means of a subsidy, as is being done in many countries to-day. The rights of the individual would have been conserved, thousands of lives and millions in property would have been saved, better lines would have been built and better maintained, while at the same time many lines that have proved useless, ruining innocent investors and weakening public confidence, would not have been built.

There are, of course, many sides to this question, but, whether the opinions of the writer, as just stated, are correct or not, speculation upon it is by no means idle, since the hindsight of to-day becomes the foresight of to-morrow. And, whatever the reason, one thing is certain : very few railroads so poorly designed and constructed as were most of our early examples will be built in this country in the future.

"Pay as you go, my boy, pay as you go," was the advice of an uncle to his nephew.

"But suppose I can't pay?" asked the nephew.

"Then don't go."

Had this plan been followed, we should certainly have had fewer railroads, but these few would have been better built, there would have been fewer receiverships, and the persons who took the risks of construction would have reaped the profits.

We are but harvesting the fruits of our sins. The foreign engineers in the days of the first railroads were encouraged to build a tunnel in order to avoid a grade ; we built grades, not only to avoid a tunnel, but even to avoid a moderate cutting. Our development has taken place, not in the proper direction, but in embarrassing and unprofitable lines. In order to meet the competition of one well-built railway, a large number of poorly-located roads were forced to use locomotives of increased hauling-capacity ; this involved a greater weight on drivers, heavier demands on the track, which never was equal to the work, and the reconstruction of bridges. The civil engineer's plans were always based on the idea of catching up to the motive-power department ; generally speaking, he has not yet caught up, for a stern chase is proverbially a long chase. Through all his work may be seen that devilish question : "Will it do?" instead of : "Is it the best?" And the worst of it is that, although he usually gets the blame, he is not often the sinner. What are the real reasons why our railway track is usually not up to its work? It is not because the engineers do not know, since, except in details, the track and roadbed have not changed in form for more than fifty years; it must, then, be some external influence which restrains them from adopting what is known to them as the best plan.

It is a good rule to name no names, but in the present instance it is better to break the rule. The late John Newell found himself president of the Lake Shore & Michigan Southern Railway in 1883, and, with the foresight of real genius, began the conversion of his line from what was a very good one into the very best which could be conceived for that location. It does not detract from the brilliancy of the project, which was the first one of the kind begun on a large scale, to know that he was forced into it because the owners of the line would not permit the employment of heavy locomotives,—the only other method by which train-loads could be increased and expenses reduced at the same time; rather, one is possessed with a greater admiration for the courage which led a man, restrained in the simpler and more obvious path, still to find so splendid a way of accomplishing his object.

Be that as it may, by diverting the line, by filling up old cuts, by cutting down old fills, by eliminating highway crossings, and at the same time rebuilding bridges in a stronger manner, curves were taken out, the grades in an east-bound direction were reduced to a maximum of 16 feet to the mile (except for a single piece of 5 miles), and the whole road was brought up to a physical condition fitting it to stand any conceivable weight of motive power as soon as the board of directors should experience a change of heart. What this cost will probably never be publicly known, but certain it is that not one cent of it was charged to the capital account,—a rather remarkable fact in the annals of American railroads, where it is not an unheard of thing to borrow the money with which to pay interest; in truth, in one instance, bonds were once issued to cover the cost of re-ballasting.

By the construction of wild-cat lines, by the poor construction of needed lines, by the use of stock to secure franchises, and by a hundred other utterly unnecessary, useless, and immoral processes, the public has now been brought to regard the stock of a new company as practically valueless, and representing nothing but wind or water. The roads must, therefore, be built upon borrowed money, and then pay interest or be sold out. Except in rare instances, only the bonds have a real value, and the stockholder who has actually invested finds himself in the shambles.

This, although it seems an issue quite apart from the subject in hand, is entirely apposite. When a railway finds difficulty in meeting its fixed charges, the first thing to suffer is maintenance,—a good deal in the motive power and equipment department, but most of all, and invariably first and last, in the maintenance-of-way department.

A line is constructed on which the distances are great and the traffic light; it is built in the cheapest possible way, without much regard to physical characteristics in the matter of grades and curves, the lightest materials are used, and it is heavily bonded even before it is finished. On such a road every conceivable means of operating cheaply must be adopted; of these means the most evident is to cut down the number of trains by increasing the number of cars per train, and the only way to do this is to use heavy locomotives. In consequence, the track, always too light, and insufficiently ballasted, deteriorates rapidly, and requires renewals, which it seldom gets, since the demand for saving, as already pointed out, affects the maintenance-of-way department most virulently.

This frequently-repeated process has resulted in a type of track much different from that usually found in the older countries of the world; it is remarkably well suited to our conditions, and is not in any sense to be despised; still, it is not certain that it is the best, or that we should have had it under any other circumstances, while its evolution has been a decidedly expensive process.

It is evident now that there is really an awakening with us, not to the desirability of correcting those early mistakes in construction which the greater conservatism of the older countries enabled them to avoid, —for the desirability has long been admitted,—but to the immediate necessity for the work, which cannot be much longer delayed. The enlightened gentleman who is president of one of our largest railway companies recently called attention to the completion of one of these changes, and remarked that he should be satisfied with that as his monument; and well he may be, for few railroad companies ever attempted to operate over a more abortive location.

Current ideas, happily, are often, if not generally, diametrically opposed to those which were held a generation, nay, a decade, ago; and, although it cannot yet be claimed that the most recent developments are to prevail, yet it is safe to prophesy now that enough experience has been analyzed and recorded to hold us secure against most of the mistakes of the past.

This statement is to be qualified also by the recognized possibility that some radical change in the form of vehicle or force of propulsion may take place, which will modify the demands made upon the superstructure of the line, and thus require a change in its form.

It has been shown how the difference in form between the American and British rolling stock has been accompanied by nearly as great differences in the form of the track; but, since we are chiefly dealing with the things which are, speculation as to the possible changes in the prevailing force of propulsion need not occupy us.

Within all human probability the limit of weight per wheel has been pretty nearly reached, and nothing threatens the existing well-built track but increased speed. This is certainly coming, both with freight trains and with passenger trains, but it will come gradually, and is a much easier condition to meet than was that of increasing weight. With improved rail joints and drainage, most of the requirements are already fulfilled, because, on a perfectly smooth and rigid surface, there is no shock at any speed. Of all the inductive lessons which have been taught to maintenance-of-way engineers, this is the most important and valuable. Reasoning from a false premise, elasticity was long considered an absolutely necessary quality in track, and the belief extended even to the ballast. That there can be no such thing as true elasticity in such materials as railroad ballast is composed of should be evident enough, and that the contrary was believed, although but for a short time, is to be accounted for only through (according to Hamerton) the vast ability of the human mind to resist knowledge. It is easier to understand why the rail and ties were believed to require a display of elasticity, since it has been shown that the track has been almost always over-strained; in fact, to avoid any misunderstanding, it may be admitted that they should be very elastic; but that they should be asked to perform work which would demonstrate it—that is, be made to deflect and spring back like a piece of hickory—was a wrong idea, now pretty well exploded. Since it was born of conditions which are rapidly disappearing, it is instructive only in teaching what to avoid.

The old argument was: "Our track deflects greatly under a train; so make it as elastic as possible, in order that it may recover its normal position, and not take a permanent set."

The present reasoning is: "If our track deflects greatly under a train, it is too light, and must, therefore, be strengthened, in order that it shall not be required to display its elastic quality."

It may be regarded as a law that, the less motion there is in a railroad track as a whole, or between the adjoining parts of a railroad track, the better it will fulfill its function, the less damage it will sustain from a train, and the less the train will suffer in passing over it.

It is in this direction that the improvement in the details of track is to be expected, and these particulars will be treated in a subsequent article. In general, we shall see more regard paid to economical location, from an operating rather than from a construction standpoint, and a greater permanence will be aimed at to reduce the cost of maintenance.

THE POSITIVE VALUE OF QUIET AND BEAUTIFUL STREETS.

By J. W. Howard.

MANY and diverse motives cause men to undertake a great variety of tasks. Whatever they seek, be it pleasure, profit, or the necessities of life, they are compelled, directly and indirectly, to use city streets. The supplies which are needed for the existence of thousands of people in each city pass through some portion of the streets; either under them, in conduits or pipes, as water and gas; or upon them, in vehicles or carried by hand; or above them, through electric wires conveying light or bearing information by telegraph or telephone. The products of our labor pass to their destination through many channels of transportation, but almost always a portion of the way over the pavements of streets.

Modern conditions have changed the problem so completely that the old solutions are no longer adequate. To carry conviction of this fact, pictures often appeal to a reader better than too much text. With this in mind, the illustrations of this article have been chosen; not with a view to showing the most beautiful streets of the world, but to exhibit certain facts carefully explained under each picture. Many articles have been published concerning good roads and pavements, but too few pictures have appeared. They speak louder than words.

City streets, with their pavements and other equipments, affect each man, woman, and child. The air and daylight come to the dwellers in cities principally by means of the spaces provided by the streets. We rely upon the streets for so many necessities, comforts, and conveniences that to properly construct, equip, pave, and maintain a city street requires a careful consideration of many other needs than those of horses and vehicles. Comparatively few persons own or use horses. Electric and other powers have so reduced the number of horses that the horse is to be considered less than heretofore in our street-paving problems.

Consider for a moment a few of the many questions involved in modern street-construction. Each of the following matters must be provided for, and their relative importance and position kept in mind, by our city engineers and others who attempt to administer our thoroughfares.

They must provide for air; natural light by day and other light by night; surface drainage; sewers; pavements of roadways and

NEW YORK CITY. BROADWAY.

Streets are used by all and should interest all. Pavements are not for vehicles only. Many other interests are involved.

sidewalks ; water pipes : hydrants : posts and poles for various purposes ; wires and their arrangement, above ground when necessary, and under ground when possible ; and boxes for post-office, police, fire-alarm, and other purposes. We have need of places of public comfort, so necessary to the health and convenience of the dwellers in dense populations and so lacking in too many American cities.

Benches are welcome, and add much to certain streets with broad sidewalks. They can be placed, as in a few American and many

European cities, at selected points near the edge of the sidewalk, and sometimes elsewhere. Drinking-fountains for man and beast should appear at reasonable intervals. Many people really suffer from thirst, when on the streets of American cities. All men are not willing to enter saloons, and, if water is desired, instead of beer, soda water, or other artificial beverages, even men who do not object to saloons do not wish to ask for water there. Many men are too poor to purchase that wherewith to quench thirst. Women and children of the middle and poor classes are the greatest sufferers in hot weather because of the lack of drinking-water easily accessible to the public. Fountains, moreover, make a city homelike, and can be made after handsome patterns, thus beautifying the streets.

Special stands for affixing posters and other advertisements are in use in Paris, Berlin, Frankfort, and elsewhere. They prevent advertising from becoming an eyesore. These stands are large enough to contain a person, who may use the lower portion for the sale of printed matter, newspapers, flowers, etc.

PARIS STREET, 1740, WITHOUT PAVEMENT.
Impeding travel, causing discomfort and disease.

Grass-plots, parking, and even fountains and statuary have their proper places on the surface of many streets. Trees are useful, healthful, and handsome, and should be more used in the majority of American cities, even on a few business or semi-business streets. A visit to Washington, Buffalo, and a few other cities having trees, will convince one of the benefit and beauty of city trees. If no signs, advertisements, or wires are attached to them, trees in a street render it very attractive.

Tie-posts for horses and stepping-blocks for carriages have become

SEVILLE, SPAIN. 18TH CENTURY PAVEMENT.

System still used in Spanish and South American cities. No sidewalk, central gutter.

a source of danger on many streets. When in a poor state of preservation, they are very unsightly. But, where the population is not dense or the thoroughfare crowded with travel, such tie-posts and stepping-blocks are perfectly admissible.

The subterranean arrangement of the conduits for water, gas, steam, compressed air, electricity, and other appliances is complex, and demands the combined experience of many men. All of these

SCUTARI, OPPOSITE CONSTANTINOPLE.

Street pavement of small Turkish cities, as poor as the civilization.

TANGIERS, MOROCCO. THE KASBAH.

Pavement characteristic of the main streets of the largest Mohammedan cities. Contagious diseases lodge in it.

CAIRO, EGYPT. STREET WITH NO PAVEMENT.

Such streets are used from necessity, not for pleasure.

things seriously affect the pavement, and especially its maintenance or repair. When access to such conduits becomes necessary, indiscriminate destruction of the pavement too often results. Full power to regulate this matter should be placed in the hands of a single official, who, in turn, must be responsible to the elective or appointive power above him for the proper fulfillment of his duties and the maintenance of the pavements.

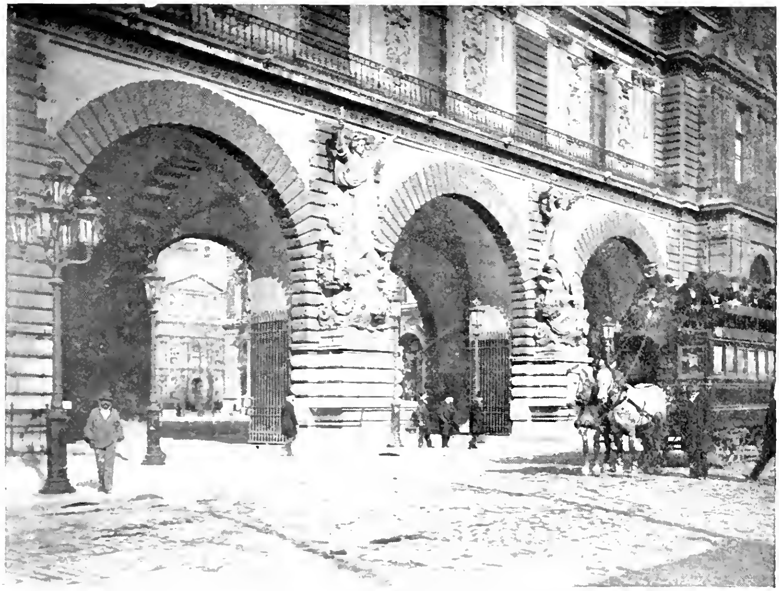
Street cars, their tracks and their needs, add difficulty to the problem, especially to the laying, maintaining, and cleaning of the pavements. Rails, switches, and flanges which project above the pavement prove very objectionable. They cause unequal wear and ruts in street surfaces, the proper repair of which absorbs thousands of dollars in each city. Generally the repairs are not made. Then the obstruction to traffic and street-cleaning causes great expense to the private and public purse. Thirty per cent. of the cost of proper repairs to pavements on streets having center-bearing, side-bearing, or other poor rails, is caused by the presence of these rails. Traffic seeks, or

GOETTINGEN, GERMANY. 18TH CENTURY STREET OF NORTH EUROPEAN CITIES.

Rough, solid pavement, with gutters at the sides.

is compelled to follow, the rails. Ruts form, and irregular wear is unavoidable. Thirty per cent. of the cost of sweeping (not removal or disposal) of the dirt from the streets of New York in 1896 was due to the poor forms of rails and the ruts they caused.

The form of steel rail which is most efficient and economical for all concerned is a firmly-set girder-rail with a flat upper surface containing a groove. The slight cost to the street-car companies of cleaning the groove at intervals is less than the cost arising from the delays due to vehicles obstructing the rapid passage of their cars.



PARIS, RIVOLI STREET AT ENTRANCE TO LOUVRE PALACE.

Grooved street-car rails prevent a street from wearing in ruts, even under extremely heavy traffic.

DUBLIN, IRELAND. SACKVILLE STREET.

A rough pavement and badly arranged tracks destroy the beauty of an otherwise handsome street.

Grooved rails save the companies the large expense (which they should justly pay) of repairing the injury to pavements traceable directly to the presence of rails of projecting forms.

No private or other enterprise upon city streets is warranted in imposing avoidable expense upon the public, or, where pavements are laid under guarantee or maintenance contracts, in imposing upon contractors the cost of excessive repairs to pavements. In equity, as well as to provide even street surfaces, city after city is following the example lately set in New York, long since established in Washington, and for many years in vogue in Europe, of permitting only flat-surfaced and grooved rails to be used on the streets.

THE PIAZZETTA, VENICE.

The pavements of many Italian cities are laid as a part of the city architecture, for beauty and utility.

The construction of pavements and roads requires as close observation, study, and supervision as other technical work. France set the example in this connection, when it established during the last century its engineering school of bridges and roads. Men were trained, scientific methods were employed, and experience was recorded for the benefit of the existing and each succeeding generation. Other nations in their engineering schools have long been doing the same.

Almost every one can think of a city, or part of a city, with disagreeable streets, either without pavements or surfaced with poor pave-

FLORENCE, ITALY. LOGGIA DEI LANZI.

Attractive streets retain successful citizens, draw strangers, and are a source of pleasure and profit to a city.

ments which absorb, breed, and disseminate germs of disease ; pavements which cannot be thoroughly cleaned, obstruct traffic, cause useless noise, and are an injury to the health, comfort, and wealth of the community. Such pavements drive away successful men, and prevent new and energetic men from coming to the city and giving it the benefit of their capital and energy. A city, to succeed, must properly pave its streets, keep them in repair, and clean them.

The utility, economy, and beauty of a pavement, fortunately, go hand in hand. The best pavements are those which are laid on solid foundations and have smooth or even surfaces. They either have no joints, or the joints are made impermeable to moisture. Such pavements are the best for wheel and foot traffic. They are the easiest to keep clean and in repair. All expenses considered, they are the most economical, and at all times handsome and attractive.

No single pavement is suited to all cities, or to all streets of one city. Asphalt, granite, brick, wood, macadam, and other materials

PARIS, AVENUE DE L'OPERA, CUT THROUGH A DENSE QUARTER.

The increased rental and tax values more than compensate for many houses removed. Business, health, and beauty are improved.

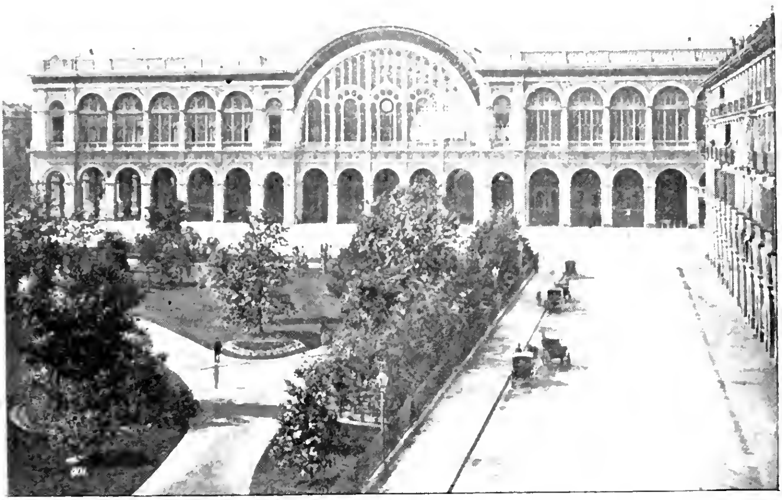
have their proper places. The problem is to decide upon the materials and methods for each street.

The construction of pavements, their maintenance or repair, and their relation to street-cleaning have lately been ably treated by others in this magazine. This article is an attempt to show the importance and difficulty, as well as the advantages and beauty, of well-equipped and properly-paved streets.

Street engineers of true worth are as much needed as bridge, sanitary, hydraulic, landscape, and other engineers. All are sub-divisions

PARIS. AVENUE CHAMPS ELYSÉES.

Central driveway, with parkways and roadways on each side. Such promenades enhance civic pride and contentment.



TURIN, ITALY. SMALL PARK AT RAILROAD STATION.

Many foreign, and a few American, cities thus make the place of arrival handsome and thereby impress strangers favorably.

PARIS. ESPLANADE BEFORE NOTRE DAME CATHEDRAL.
Laying asphalt pavement for vehicles, foot traffic, processions, and ceremonies.

BUFFALO. NORTH STREET.
A smooth, clean, quiet pavement, grass-plots, and good walks, make a satisfactory setting for homes.

NEW YORK CITY, CHRYSTIE STREET.

Children, especially in tenement districts, must play in the streets; hence the greater need of clean pavements.

of civil engineering. Such men are steadily replacing mere politicians and the ignorant or apathetic employees of cities or contractors. They accomplish maximum results with minimum expense. They unite theory and practice of the past and present. They have access to the recorded experience of others, and thus avoid useless experiments.

The results tells the story. Compare the new asphalt and granite pavements of New York with those of 1887. Examine the streets of Washington, Paris, London, Berlin, and a few other cities, and you will find the good results of honest administration, with trained men in charge of pavements. Every thinking man can name other cities, where the poor pavements indicate either that

PHILADELPHIA, SECOND STREET. A NEGLECTED PAVEMENT.

The public in some cities may be educated down to enduring such a cause of offense.

NEW YORK, NASSAU STREET.

Valuable buildings on a narrow street need a smooth, clean, and quiet pavement to make the lower offices valuable.

honesty is not present, or that trained, educated men are not in charge of street-construction.

Examples of attractive pavements and handsome streets are easily found in America, for great progress has been made here, although it is but a grand beginning. European cities are generally more complete, as a whole, but it is no longer necessary to cross the Atlantic to see what can be done in the matter of pavements.

The sale or rental value of real estate increases beyond the expense of the improvement when a good pavement has been laid, especially when noise has been guarded against by proper choice and laying of material. Noise was formerly regarded by many as a necessary evil in

NEW YORK, PARK AVENUE.

The central part of a wide roadway should often be parked and beautified.

NEW YORK, WASHINGTON SQUARE, SOUTH END OF 5TH AVENUE.

A handsome pavement on a solid foundation is not injured by the heaviest load.

WASHINGTON, D. C. CONNECTICUT AVENUE.

Flat grooved rails, firmly set, should have the asphalt pavement laid against them.

WASHINGTON, D. C. THOMAS CIRCLE.

One of many green spots with good pavements about them which are so agreeable in well-finished cities.

connection with durable pavements. The asphalt, wood, and brick are used with success in reducing noise. Some brick pavements, however, when laid in cold weather and with rigid base, often give forth a disagreeable, hollow, rumbling sound.

Another marked improvement is the elimination of cross-walks or bridge stones where they are useless and unsightly, because a street, if properly paved with asphalt, wood, or even granite, can be crossed on foot at any point.

The narrowing of paved roadways of residence-streets, away from the centers of cities, is advisable, especially when smooth pavements are used. This is because such a surface facilitates rapid traffic ; as the vehicles pass in less time, less width of roadway is needed. Not only is the expense of much extra pavement saved, but often space is obtained for grass plots between the sidewalk and curb of the street, as shown in the picture of North street, Buffalo.

It is natural and proper that people should take pride in a street well furnished with all that serves the needs of a high civilization. Such streets and their pavements benefit those living upon them. They cause an improvement in the appearance of the people—especially in tidiness of houses, dress, and even manners—in the poorer parts of cities.

The health of the people is improved, and the death rate diminished, where impermeable pavements are used. The dust and dirt which get into our houses come from the street. Disease germs are thus brought to us when a kind of pavement which absorbs or retains matter is used in a densely-populated city.

Good pavements and attractive streets have an ever-increasing army of friends. The general use of the bicycle has helped to spread knowledge of this subject, especially because the possessor of the propelling power (the legs) can feel the superiority of smooth roadways, and can talk. The horses have long suffered while drawing heavy loads over rough streets, but could not complain. If they could have talked, we would have learned, generations ago, what too few people were then willing to observe. When motor vehicles or horseless carriages shall be at last in practical daily use, a new army of advocates will be added to the common cause of good pavements.

COMPARATIVE ECONOMY IN ELECTRIC-RAILWAY OPERATION.

By Charles Henry Davis.

BUT little has been written upon the subject of coal consumption on electric railways; except in isolated cases, of specific plants undergoing test, no great collection has been made of data available for comparison, or which can be used to arrive at correct conclusions. The writer undertook to collect sufficient data to determine reliable averages of coal consumption per car-mile, and to show the comparatively small percentage of saving in operating expenses per car-mile in power stations of the greatest economy over those of minimum economy, compared to the large percentage which can be saved in other departments with the same expenditure of capital; or, in other words, the undesirability, in many cases, of expending large sums of money on concentrated, compound- or triple-expansion, condensing-engine plants to save a comparatively small percentage of the cost of operating per car-mile, when part or all of the same amount spent upon other items, which are a larger percentage of the total operating expenses, would result in greater savings.

In the October, 1896, number of THE ENGINEERING MAGAZINE, under the title, "The Economy of the Modern Engine Room; II. The Problem of Engine Selection," the writer gave the following as fair average steam consumption in pounds per h.-p. hour for railway work (balance of table omitted here):

TYPE OF ENGINE.		POUNDS OF STEAM. NON-CONDENSING.	CONDENSING (C).
High-Speed	(H. S.)	36	31
High Speed Compound	(H. S. C.)	27	22.5
Corliss	(C)	31.5	26.5
Corliss Compound	(C. C.)	26	23

This table shows a saving of 36 per cent. between the high-speed engine plant running non-condensing at 36 pounds of steam, and the Corliss compound-condensing at 23 pounds; Table No. 3 shows that the high-speed engine plant averages about 15 pounds of coal per car-mile, while the Corliss compound-condensing averages about 8 pounds, —a saving of 46 per cent., sufficiently close to the 36 per cent. given above to indicate that the coal tables give fairly accurate averages. By examining the coal tables we are led to the conclusion that the efficiency of each system is approximately the same, for we find, in general, that, where the number of car-miles is high, the consumption of coal per car-mile is low; in the north central and western States, where coal is not of as good quality as in the eastern States, the consumption is higher (assuming, as we safely can, for our purpose, that the economy of various types of boilers is practically the same); with roads using hard coal there is an apparent higher average in consumption of coal, no doubt due to lower car-mileage and fewer cases; and in engine plants, as more economical apparatus is used, the coal consumption decreases. It would therefore seem that we are correct in assuming that the total efficiency of each system is approximately the same, though varying in each part that goes to make up the whole. The variation from 25.9 maximum to 5 pounds minimum shows the approximate value of this information, and the engineer is able to predict results only from careful tests and thorough knowledge of local conditions.

Omitting exceptional cases, both as to minimum and maximum, it is found that the cost of operating an electric railway under ordinary conditions is about 13 cents a car-mile, divided about as follows with coal at $3 per ton of 2,240 pounds: *

Power,	$ .015,	11.5%,
Cars,	.025,	19. %,
Track and line,	.035,	27. %,
Car labor,	.055,	42.5%,
	$ .13 cents.	

It is seen that power is eleven and one-half per cent. of the total operating expenses per car-mile; the coal item will average about 50 per cent. of the power-house expenses, or about 5.75 per cent. of the total expenses per car-mile. Fifteen pounds of coal per car-mile can safely be depended upon with high-speed engines running high pressure and single expansion, but this can be reduced to about eight pounds with the most economical steam plants. From these figures it appears that a maximum saving of 46 per cent. of the coal, or of 2.6 per cent. of the total cost per car-mile, could be made by the use of the most economical plants as compared with single expansion. We assume that, on an average, high-speed engine plants burn about 4 pounds of coal per horse-power per hour, equivalent to an evaporation of about 9 pounds of water per pound of coal. If 2.6 per cent. is the maximum saving which can be realized, the chances are that, under most circumstances, far less is likely to be accomplished. Most en-

* See "Facts and Figures Interesting to Electric Railroad Men," third edition, by the author.

gineers agree that, above 5,000 horse-power or even less, there is usually no material saving in further concentration of power, and compound-condensing plants do not show enough saving in small stations to more than balance the interest on the greater cost. To effect the above saving, bearing in mind the last two statements, would necessitate expending anywhere from 100 per cent. to 30 per cent. more in first cost, depending upon the size of the station. Suppose a part or all of this increase were spent on better car bodies, trucks and motor equipments, or on track and feeder lines (including returns), resulting in a saving not only in each of these departments, but in that largest of all items, car labor, by increasing the speed without danger to the public. A saving of 10 per cent. on cars, 7.4 per cent. on track and line, or 4.7 per cent. on car help, would amount in each case to a saving of 2.6 per cent. per car-mile, equivalent to a saving of 46 per cent. in the coal pile, and could probably be accomplished, in any given case, with a smaller expenditure of capital.

An example may more distinctly indicate the truth of this position. The following table has been prepared from data obtained from two electric railways designated as 1 and 2. The first shows lower cost of operating per car-mile, due to heavier and better track, line, and equipment, although the power plants are about equal in economy; note also the fact that the indicated horse power per car used is much lower in road 1 than in road 2.

A COMPARISON OF ECONOMY IN ELECTRIC-RAILWAY OPERATION.

	ROAD.	
	No. 1.	No. 2.
Street length, miles	4.11	6.00
Street length, feet	21,700	31,680
Track length, miles	7.54	6.36
Track length, feet	39,811	33,584
Steepest grade—per cent.	5.2	6.0
Length of steepest grade—feet	475	500
Number of motor cars	12	7
Number of trailers	15	4
Average total cars used at once	9	4
Indicated h. p. of engines	425	300
Indicated h. p. per car used	47	75
Car miles operated	317,656	92,400
Operating expenses per car-mile—cents	9.77	13.68
Total operating expenses	$31,030.	$12,640.
Total cost of road and equipment	266,730.	115,694.
Approximate cost of buildings and real estate	30,000.	15,000.
" " " power plant	29,750.	30,000.
" " " equipment	58,500.	16,800.
" " " track and line	148,480.	53,894.

It will be seen that the cost of track and line in the first case is about $20,000 per mile, while in the second case it is about $8,500. Part of this difference is due to cost of paving in the first case, which averaged about $5,000 per mile ; the rest is due to heavier rail, ballasting, substantial ties, heavy pole work and feeder lines, and proper bonding and returns, while the equipment was heavier and more powerful and substantial on road 1, thus giving lower operating expenses.

The writer does not want it understood that he is not in favor of concentrating, compounding, and condensing where conditions show an actual saving when taking into account the interest on the increased cost ; but he calls attention to the enormous amounts spent on 10,000 and 20,000 h.-p. plants, and even higher horse powers concentrated at one point, which do not produce a horse power any cheaper than smaller stations, and which cost more per horse power and force tremendous investments for feeder systems, and in their large cost cut down the amounts that managers of corporations allow (or have left) for the other and more important items. It should be remembered that these items offer a large field for saving, because of their greater percentage of the whole. It is interesting to note, as bearing on this subject and as additional indication of the correctness of our position, that a steam road, from which the writer has data, using over 200,000 tons of coal per annum and operating over 42,000,000 car-miles, consumes about eleven pounds of coal per car mile in its locomotives. Remembering that the weight moved, in this case, is considerably more than double per car (exclusive of other conditions), and that small detached steam plants are used, running high pressure and single expansion, this is a strong point against the prevailing methods of our large electric-railway systems. Should the rotary transformer be extensively used, the correct solution of any problem might be different, for the problem of current distribution is of an entirely different character.

The amount of coal consumed per car-mile is dependent upon so many conditions, often unknown, that this amount, in any given case, cannot be used to predict what the consumption will be on another road ; hence the importance of taking a large number of cases upon which to base our average results, which may then be considered fairly reliable for the determination of possible results in any new case. It will readily be seen that the amount of coal consumed per car-mile depends upon the tons moved, the height through which each ton is moved, the speed, and the efficiency of the entire system ; the first three are almost impossible to obtain on any large number of roads from the ordinary records kept, and can usually be secured only by specially-arranged tests ; the efficiency of the system depends upon that of each part, such as the boiler plant, engines, condensers and piping, generators, over-head line, ground return, track, and equipment. High economy in all but one part of the system might cause

TABLE No. 1.

	STEAM PLANT.				COAL.			
Road.	State.	Miles.	Boilers.	Engines.	Kind.	Coal field.	Tons used, 2240 lbs.	Lbs. used per car-mile.
			NORTH ATLANTIC STATES (as per U. S. Census—1890).					
56 E	Maine	116,926	V. T.	V. C.	S	Virginia	508	9.7
42 E	Massachusetts	196,824	R T.	C. C. C.	S	Georges Creek, Md.	939	10,7
65 E	"	16,794 961	....	....	S	....	52 878	7.0
189 E	"	917,956	W. T.	H. S. C. C.	S	Georges Creek, Md.	2,201	5.4
74 E	"	873,177	....	....	S	....	2,262	5.8
451 E	"	226,123	R. T.	C. C.	S	....	504	5.0
308 E	Ohio	1,378,518	....	....	S	Pennsylvania	3,189	5.2
802 E	Connecticut	146,000	V. T. / R. T.	H. S. C.	S	....	1,000	15.3
398 E	New York	819,000	V. T.	V. C. C	S	Pittsburg	2,176	5.9
78 E	"	2,162,134	W. T.	V. C.	H	....	8,758	9.1
249 E	"	637,290	W. T.	H. S. C C. / C. C. C.	S	....	5,100	17.9
214 E	"	199,290	W. T.	....	S	....	1,460	16.4
281 E	"	350,000	W. T.	H. S.	S	Reynoldsville, Pa.	1,200	7.7
181 E	"	295 325	R. T.	V. C. C.	S	Clearfield, Pa.	682	5 2
80 E	"	7,164,258	W. T.	V. C. C.	S	Reynoldsville, Pa.	23,597	7 4
724 E	"	137,970	V. T.	H. S.	H	....	1,460	23.7
609 E	"	4,558,136	....	....	S	....	19,043	9.3
842 E	"	73,377	R T.	H. S. C. C.	S	....	640	19.5
608 E	"	247,482	....	....	S	....	1,130	10.2
90 E	New Jersey	87,923	R. T.	H. S.	S	Clearfield, Pa.	387	9.8
558 E	Pennsylvania	149,730	R. T.	H. S.	S	....	1,231	18.4
229 E	"	600,000	V. T.	V. C.	H	Hazleton, Pa	3,600	13 4
211 E	"	514,989	R. T.	C.	H	Girardville, Pa.	2,852	12.4
54 E	"	400,648	W. T.	H. S. C.	S	Dawson, Pa.	1,697	9.4
580 E	"	501,400	W. T.	H. S.	H	Schuylkill Co., Pa.	2,250	10.0
103 E	"	833,000	R. T.	C. C.	H	Liken's Valley, Pa	3,000	8.1
			SOUTH ATLANTIC STATES (as per U. S. Census—1890).					
811 E	D. of Columbia	534,000	V. T.	H. S.	S	Cumberland, Md.	1,800	7.5
809 E	"	365,000	R T.	C	S	" "	1,500	9.2
813 E	"	528,500	W. T.	H. S. / H. S. C.	S	W. Virginia	2,030	8.6
128 E	Georgia	98,550	W. T.	H S.	S	Alabama	638	14.5

the pounds of coal per car-mile to be high, and it is therefore impossible, without special test, to accurately determine the cause of low efficiency in any given case. By taking a large number of cases, and eliminating those which are evidently far from the average, we get approximate information indicative of what we may expect.

The information given in the tables was obtained by the writer during the winter of 1894-95. Over 600 roads were addressed, from nearly all of which replies were received; much of the information sent was evidently largely guess-work, not based upon carefully-kept records; many wrote that they had no information that would enable

TABLE No. 1 CONTINUED.

Road.		State.	Miles.	Boilers.	Engines.	Kind.	Coal field.	Tons used, 2240 lbs.	Lbs. used per car-mile.
NORTH CENTRAL STATES (as per U. S. Census—1890).									
648	E	Missouri	2,021,938	V. T.	C.	S	Illinois	16,670	18.5
150	E	Ohio	449,680	....	C.	S	Jackson Co., Ohio	2,555	12.7
576	E	"	331,000	R. T.	H. S.	S	Wellston, Ohio	1,500	10 1
220	E	"	363,040	R. T.	C.	S	" "	2,300	14.2
222	E	Indiana	319,345	V. T.	C.	S	Illinois & Indiana	3,140	22.0
107	E	Illinois	1,514,892	W. T.	C. C.	S	... .	9,080	13.3
43	E	"	530,000	W. T.	H. S. C. / H. S C. C.	S	Streator, Ill.	4,400	18 6
256	E	"	425,000	R. T.	C.	S	" "	3,500	18.4
250	E	Wisconsin	150,000	R. T.	H. S.	S	Duquoin, Ill.	1,500	22.4
594	E	"	515,000	W. T.	V. C. C / H. S. C. C. / C.	S	Pittsburg, Pa.	2,190	9.5
170	E	Minnesota	1,133,188	W. T.	C. C. C.	S	....	5,510	10.9
148	E	Iowa	1,549,060	V. W. T.	H. S C.	S	Violo, Ill.	11,400	16.5
257	E	Missouri	223,130	R. T.	H. S.	S	Pittsburg, Kan.	2,090	21.0
648	E	"	2,021,938	....	....	S	....	16,670	18.5
825	E	"	395,650	R. T.	C.	S	Crawford Co., Kan.	2,150	12.2
743	E	"	378,995	R. T.	C.	S	Pittsburg, Kan.	1,980	11.7
53	E	Nebraska	100,000	R. T	H. S.	S	Kansas	800	17.9
295	E	"	1,145,158	V. T. / R. T.	H. S. / H. S. C.	S	Iowa & Missouri	9,802	19.2
WESTERN STATES (as per U. S. Census—1890).									
157	E	Colorado	3.451,136	R. T.	C. / H. S.	H	Trinidad, Col.	25,000	16.2
901	E	"	138,375	R. T.	H. S.	S	Colorado	1,350	21.8
463	E	Utah	201,890	R. T.	C. C. / H. S. C.	S	Rock Spring, Wyo. / Pleasant Valley, Utah	839	9.3
660	E	"	658,416	R. T.	H. S.	S	Rock Spring, Wyo. / Pleasant Valley, Utah	3,328	11.3
704	E	Washington	157,832	.. .. ..	....	S	......	1,825	25.9
457	E	California	923,694	R. T.	C. C.	S	.. ..	2,436	5.9
751	E	"	424,529	R. T.	H. S. C. C.	S	....	1,250	6.6
CANADA.									
796	E	Brit. Columbia	381,400	R. T.	C. C. C.	S	British Columbia	1,200	7.0
777	E	Ontario	6,212,045	W. T. / R. T.	C. C. C. / H. S. C. C.	S	....	18,535	6.7
364	E	Quebec	4,888,486	F.	C. C. C.	S	Cape Breton, N. B.	16,456	7.5

them to reply intelligently or accurately; while about three hundred gave data more or less reliable, from which the writer has selected fifty-eight as seeming most trustworthy. The sub-divisions of the United States census of 1890 have been followed.

Table No. 1 gives the road by index number, the State where located, the car-miles, kind of boilers, engines, and coal, the field from which coal was obtained, the long tons of coal used in the given fiscal year, and the pounds of coal consumed per car-mile.

Table No. 2 gives the average, highest, and lowest pounds of coal per car-mile, grouping the roads by territorial sub-divisions and kinds of coal, with the number from which the averages have been calculated.

Table No. 3 gives the average, highest and lowest pounds of coal consumed per car-mile for different classes of engine plants, with the number of roads from which the averages have been calculated.

While the ton-mile should properly be the basis, yet the difficulty of determining the number of ton-miles has led to the adoption of the car-mile as the best practical unit of comparison.

TABLE No. 2.

AVERAGES.—NUMBER OF ROADS AND AVERAGE POUNDS PER CAR-MILE.

LOCALITY.	Number.	Pounds Per Car-Mile.		
		Highest.	Lowest.	Average.
ALL ROADS.				
North Atlantic States	26	23.7	5.0	10.65
South Atlantic States	4	14.5	7.5	9.95
North Central "	18	22 4	9.5	15.97
Western "	7	25.9	5.9	13.86
Canada	3	7.5	6.7	7.2
Totals and Averages	58			12.46
ROADS USING SOFT COAL.				
North Atlantic States	20	19.5	5.0	10.01
South " "	4	14.5	7.5	9.95
North Central "	18	22.4	9.5	15.97
Western "	6	25.9	5.9	13.46
Canada	3	7.5	6.7	7.2
Totals and Averages	51			10 38
ROADS USING HARD COAL.				
North Atlantic States	6	23.7	8.1	12.78
South " "	.	...	...	.
North Central "	..	....	...	.
Western "	1	....	. .	16.20
Canada	..	....	...	...
Totals and Averages	7			13.27

TABLE No. 3.

AVERAGES (AS PER GROUPING OF ENGINES).

ENGINE PLANT.	No. of Roads.	Pounds Per Car-Mile.		
		Highest.	Lowest.	Average.
C	9	22.0	9.2	14.5
C.C	7	13 4	5.0	9.2
C.C.C	7	10.9	5.2	8.0
H.S	13	23.7	7.5	15.0
H.S C	3	16.5	9.4	13.7
H.S.C.C	3	19.5	5.4	10.5

Note :—

F. = Flue.
V.T. = Vertical tubular.
R.T. = Return "
W.T = Water tube.
V.W.T. = Vertical water tube.
C. = Corliss.
C,C. = " condensing.
C.C.C. = Corliss compound-condensing.
H.S. = High speed.
H.S.C. = " " condensing.
H.S.C.C. = " " comp'd-condensing.
S. = Soft coal.
H. = Hard "

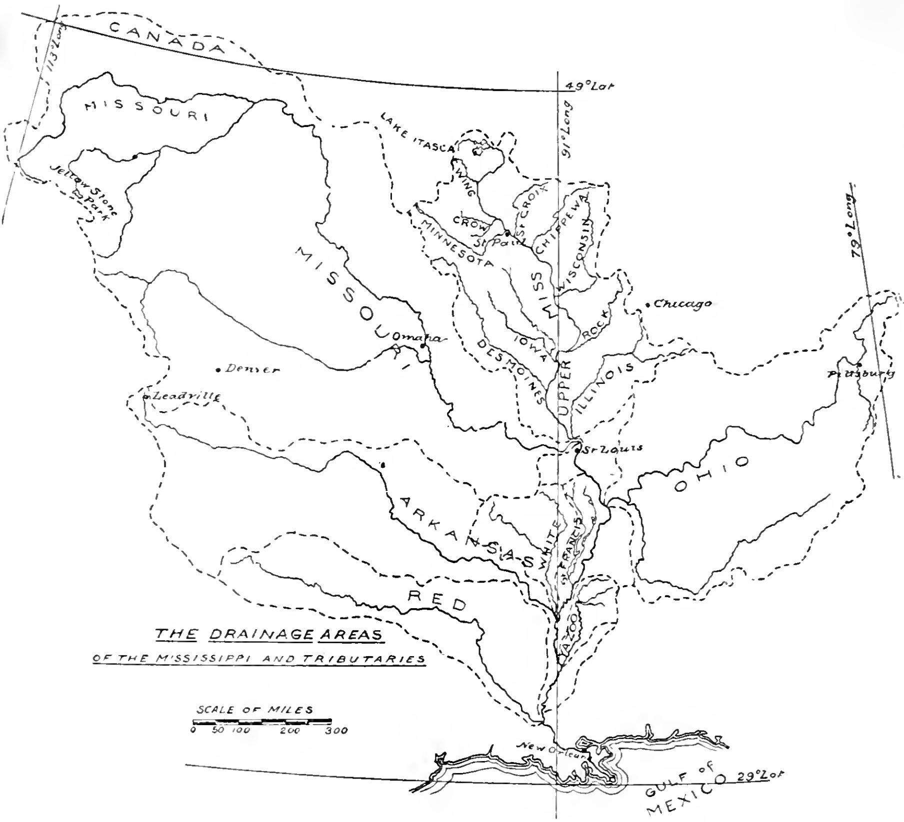
THE TIMES AND CAUSES OF WESTERN FLOODS.

By James L. Greenleaf.

THE prime factors governing the chronological distribution of flow from any drainage basin are the two prominent climate features,—namely, the variation in the intensity of rainfall and of temperature through the successive seasons of the year. The relation between cause and effect is so direct in this case as to be obvious to all ; indeed, the statement may almost be classed with the axioms of science. Should it chance, however, to need the endorsement of a "Q. E. D," such is readily found in the chronological table for the Mississippi presented on another page.

Working behind the two prominent causes, modifying and blending their effects with infinite complexity, are a great variety of features of climate, soil, and topography. Among the more prominent are the hygrometric state of the atmosphere as affecting evaporation from land and water surface, the sandy or the impervious structure of the ground, the character of vegetation, the hilly or level nature of the country, and the proportion of swamp and lake surface to dry land. A moment's thought will suggest how these conditions may, in a secondary degree, modify, not only the amount, but also the time, of high or of low water. For example, certain of them may retard or facilitate the "run off" of heavy rains, and others, by a delicate adjustment, may determine whether the lowest water of the year shall occur in the freezing weather or when evaporation is most active. These features of climate, soil, and topography sometimes—to borrow an illustration from the field of politics—hold the balance of power between the two predominating factors which control the flow, and stand ready to cast the weight of their influence in either direction. The effect of the secondary factors is so subordinated, however, in taking a broad view of the Mississippi system, that, in its case at least, rainfall and temperature are the only two causes which can profitably be related to effect when studying the chronology of discharge from its water-courses.

The country drained by the Mississippi is topographically divided into several large water-sheds, each named from its most important river. They are too familiar to require description, but it may be well, in passing, to recall them, and state their respective sizes.



THE DRAINAGE AREAS OF THE MISSISSIPPI AND TRIBUTARIES.

The Upper Mississippi (to the mouth of the Missouri)	173,000	square	miles.
The Missouri	528,000	"	"
The Ohio	214,000	"	"
The Arkansas	161,000	"	"
The Red	97,000	"	"
All other tributaries, of which the St. Francis, White, and Yazoo are chief	86,000	"	"
Total of the Mississippi water-shed	1,259,000	"	"

Although this topographical division into the several water-sheds of the principal tributary rivers has been wrought by natural causes, one is tempted to depart from it in the present study, and deal instead with what may be called climatic areas. The inducement is that climate to a great extent ignores water-shed lines, and groups parts of adjoining river basins under the same circumstances of rainfall and temperature. For instance, the upper waters of the Arkansas and Missouri are, broadly speaking, subject to somewhat similar winter conditions, markedly different from those active in the regions about their mouths; and, again, the Yazoo, St. Francis, and, to a certain extent, the lower waters of the Arkansas, drain a belt of country characterized throughout by a heavy winter and spring rainfall. Nevertheless, for clearness of treatment, it is advisable to adhere to the divisions into the tributary water-sheds, whose names are familiar and convey definite ideas of locality. These water-sheds are arranged in the table here presented in four groups, which, as far as possible, cluster the rivers according to their pronounced characteristics of flow-period and climate. The fifth division is an analysis of conditions existing in the extreme northern part of the Upper Mississippi water-shed. The table is simply a condensation and grouping of the prominent facts,—those truths which stand out in clear relief upon the mass of detail concerning the chronology of flow.

We read from the table that all the rivers tributary to the Mississippi show a decided tendency toward low water in the autumn. The southern rivers begin to fall from a high stage in June, and the northern rivers in July. All begin to rise from low water in the winter. The southern tributaries show a decidedly increased flow in January, the Ohio in late January, the Missouri and Upper Mississippi in February. Two principal freshets occur during the year in each of the large tributary basins. Considered broadly, and for all the large tributaries, the period from February into June covers the time of occurrence of the two highest stages of the year. Between these two stages of especially high water, a fair and even high state of flow is maintained. There is a tendency for the higher of the two rises to occur in late winter or early spring on the southern tributaries, whereas the Upper Mississippi and Missouri reach their yearly culminations in the latter part of spring and summer. The coincidence of highest stage in more than two of the large branches is extremely rare, and hence it is an exception for the main river to be subjected to the enormously-congested state which would otherwise result.

Such being the prominent facts, it is in order to search for their underlying causes. The first clue to arrest attention is that a decided tendency to a light rainfall in the late summer and in autumn prevails over the entire Mississippi water-shed. It is true that the northern and the elevated regions have their smallest rainfall in the winter, and of this a large part is stored in the form of snow and ice; yet the fall amount comes next in order, and is very light. For the central, and

CHRONOLOGICAL TABLE OF FLOODS AND LOW WATER FOR THE TRIBUTARIES OF THE MISSISSIPPI.*

Tributary rivers.	Comparative rainfalls grouped according to three-month periods.	Time of beginning the rise from the low period.	Time of occasion of the highest stage.	Time of occasion of the next lower flood.	Time of beginn'g of the fall to the low period.	Time of occasion of the lowest stage not due to freezing.	Time of occasion of the winter drop.
Yazoo	Sp. rain,-max (18. ins.) Wi. " (16. ") Su. " (11. ") Au. " (9. ")	January	April	Irregular	June	July to Dec. (leaning to Nov.)	
St. Francis	Sp. rain,-max (12.5 ins.) Wi. " (10. ") Su. " (10. ") Au. " (8.5 ")	January	late March	Irregular	June	Sept. to Dec. (leaning to Nov.)	
White	Sp rain,-max (13. ins.) Su. " (11. ") Au. " (10. ") Wi. " (8. ")	January	Feb. to May	Irregular	June	Aug. to Dec. (leaning to Sept. to Nov.)	
Red	Sp. rain,-max (11.5 ins.) Su. " (10. ") Au. " (8.5 ") Wi. " (8. ")	January	Feb. to May	Irregular	June	Aug. to Dec. (leaning to Sept. to Nov.)	
Ohio	Sp. rain,-max (12. ins.) Su. " (12. ") Wi. " (11. ") Au. " (8.5 ")	late January	Feb. to March	Apr. to May	June	Oct. to Nov.	
Arkansas	Su. rain,-max (9. ins.) Sp. " (8.5 ") Au. " (6. ") Wi. " (4. ")	January	Apr. to May (sometimes February)	February (sometimes Apr. to May)	June	Aug. to Dec. (leaning to Oct. to Nov.)	
Missouri	Su. rain,-max (6.5 ins.) Sp. " (6. ") Au. " (4.5 ") Wi. " (3. ")	early Febr'ary	June	April	late July	Sept. to Nov. (leaning to Oct.)	late Nov. into Dec.
Upper Mississippi	Su. rain,-max (13. ins.) Sp. " (9. ") Au. " (8. ") Wi. " (4.5 ")	February	Apr. to July	Feb. to March	late July	Aug. to Oct.	Dec.
Mississippi ab've mouth of the Minnesota	Su. rain,-max (10.5 ins.) Sp. " (7. ") Au. " (6.5 ") Wi. " (2.5 ")	early April	April to May (sometimes June to July)	June to July (sometimes April to May)	late July	Aug. to Nov.	late Nov. into Dec.
Minnesota	Su. rain,-max (12. ins.) Sp. " (7. ") Au. " (6.5 ") Wi. " (2.5 ")	early April	April to May (sometimes June to July)	June to July (sometimes April to May)	late July	Aug. to Nov. (leaning to early Oct.)	late Nov. into Dec.

* When a writer records definite statements concerning variable conditions, he does so at his peril. There are, doubtless, grey-haired rivermen, familiar with the Mississippi from their boyhood, who would drive their stern-wheelers right through the above table, without a moment's hesitation. Moved by a natural desire to avoid disasters of this nature, I may remind those navigators who claim the right of way that individual opinions concerning times of high and low flow are very liable to be influenced by special occasions of freshet or drouth, which have impressed themselves upon the memory. The conclusions here presented, on the contrary, are the result of an impartial study and averaging of the large series of gagings of the various rivers which have been recorded and published by the engineer corps of the United States army and by the Mississippi river commission. They should be understood, therefore, to represent average conditions, from which the rainfall and climate of any particular year may cause wide departures.

particularly the south-central, portion of the Mississippi water-shed the autumn rainfall is the lowest of the year. This widespread condition of light rainfall, occurring at the time when the atmosphere is driest, the power of the sun still strong, and evaporation from the ground most pronounced, readily accounts for the prevalence of low water throughout the Mississippi water-shed in the fall. Further, it becomes apparent, in passing up the center line of the Mississippi valley, that, while in the south the spring rainfall is the greatest of the year with the summer rainfall well up toward it in amount, the order of precedence is reversed further north. This fact, together with the earlier demands of vegetation and evaporation in the south, suffices to explain the tendency of the southern rivers to begin falling in June, and of the northern streams to hold on into July.

The low flow reaches a minimum, as a rule, some time in October or November, upon all the tributaries of the Mississippi. It is often broken by a sudden and uncertain freshet, caused by brief autumn rains. This rise, pronounced though it may be at times, is too erratic to be noticed, except as an incident among the regular changes of the year. Upon the Upper Mississippi and Missouri there is a drop,—for so it is best described,—when winter cold sets in, to what is frequently the lowest water of the year. The sudden falling off in the volume of flow at this season is due to the freezing of the multitude or little water-courses supplying the larger streams, and to the change from rainfall into snow, which is stored until the spring.

The reasons for the times of flood in the tributaries of the Mississippi are more involved than those for the times of low water, and therefore require more comprehensive discussion. Yet it will be seen that they also group themselves about the distribution of rainfall and of temperature,—the two dominant climatic features which have been shown to control the periods of low flow. It will aid one in appreciating the causes which determine the times of high water if he conceives a bird's-eye view of the Mississippi water-shed. Upon this mental picture may now be sketched the conditions of rainfall and of temperature as they change with the succession of the seasons, and the resulting stages of the river can be traced.

The winter rains are especially heavy over the water-sheds of the Yazoo, St. Francis, and White, and upon the lower regions of the Arkansas and Red. The moist air currents which supply these rains have a marked tendency to sweep to the north-east, well up the valley of the Ohio, and make its winter rainfall also prominent. They reach the lower edges of the Upper Mississippi and Missouri water-sheds, but those rivers, as well as the head-waters of the Arkansas, are still throttled by the cold. Evaporation is slight. Where the climate is not extreme, but where the ground is sufficiently elevated to induce the formation of snow and ice, early thawing swells the streams. Hence the month of January sees the southern rivers rising. The Yazoo and St. Francis, with their heavy rainfalls distributed throughout the year, are well up in late winter, and growing toward a usual maximum in March or April, when the special concentration of rainfall occurs. It may be remarked, in passing, that their water-sheds comprise no elevated land, and are not subject to any appreciable amount of thawing of ice and snow. Partly in consequence of this, there is no particular tendency to the two well-defined periods of high water, with a fall intervening, which will presently be shown to characterize the larger tributaries. One or more falls may alternate with rises, but these are due to irregular variations in the rainfall.

The Red river is rising toward its highest point, which, possibly, it will not reach until the April or May rains have asserted their predominance. The White is showing much this same variation.

The Arkansas, although its upper waters are still locked fast in the mountains, feels the effect of rain upon the lower water-shed. It is affected by two marked differences of condition. The lower regions of the water-shed are subject to features of rainfall and temperature similar in nature, and largely in degree, to those commanding the water-sheds of the Yazoo, St. Francis, and White. The upper waters are frozen fast in winter, and, moreover, the period of special concentration of rainfall occurs upon this elevated region in the summer. Hence the winter and early spring rains upon the lower regions, very slightly subjected to evaporation, and aided by some melting of snow and ice, raise the river to a decided freshet. The late spring and early summer rains upon the upper regions, swollen by melting snow among the mountains in case that is so long retarded, and added to a very considerable rainfall on the lower portion of the water-shed, cause another freshet in late spring. This tendency to two periods of high water is very marked. Essentially similar conditions are in force upon all the large water-sheds tributary to the Mississippi.

Some time in February or March the Ohio reaches its highest flood. This is due to the melting of snow and ice, added to a heavy rainfall. The spring rain is the greatest of the year on the Ohio water-shed, although it cannot equal the effect of the heavy winter rains combined with the thawing of the snow. So the Ohio falls somewhat after the February thaws, only to rise again to the next highest stage of the year with the rains of April and May.

In February the lower regions of the Missouri and Upper Mississippi have felt the rains and thaws and the rivers rise decidedly. Their upper waters, however, are still held back by the winter's cold. The latter part of February or the early part of March sees the break-up on the Upper Mississippi, which then rises to the second highest stage of the year, largely because of the melting of snow and ice. The heaviest rainfall upon its water-shed is in summer, and it is, therefore, between late spring and July that the highest water occurs. The same sequence is found, six or eight weeks later, at the sources of the Upper Mississippi. The melting occurs there in April or May, and, with the rainfall, causes a freshet. This is succeeded by a lower stage, until the June and July rains once more raise the river. The latter generally is the greatest freshet of the year, but the honors are nearly evenly divided with the spring rise.

The Missouri shows somewhat the same characteristics as the Upper Mississippi. The relative distribution of rainfall through the four seasons is about the same as for that river, but the temperature conditions vary greatly in different portions of the water-shed. The upper waters spring from a high altitude among the Rocky mountains, which retains some of the characteristics of a winter climate long after spring has made itself felt at the sources of the Mississippi. Hence the thawing has effect upon the river until May, and, in fact, snow is still feeding the river in the mountains until June is passed. There is a culminating stage in April, caused by rain-fall and the passing out of the snow and ice, but the greatest rise is in June. This is due to the rainfall of late spring and early summer, which is the heaviest of the year. Then the decline toward the low water of autumn commences.

The Missouri closes the list of chief divisions of the Mississippi system, so that the way is now prepared for gathering the various lines of investigation thus far followed, and, by their means, interpreting the cycle of fluctuations in the main river. The Mississippi reflects unerringly the variations of rain-fall and temperature which occur upon its tributary basins. So much may be assumed as a fact beyond dispute. Yet, even granting an understanding of the rain-fall and temperature, who can say precisely what the stage of the river will be at any particular time? So infinite are the possible combinations of amount, time, and place in the variations of rainfall and temperature over the Mississippi water-shed that minute analysis is futile. Close students of the river may, it is true, follow the flood-waves of any particular year as they pass down the channel, and note the effect of each entering stream upon their progression, but precisely such a series of combinations may never occur again. It is impossible to foretell what the conditions will be for a single season.

Nevertheless, the truth remains that the varying stages of the Mississippi accurately reflect the fluctuations of rainfall and of temperature which occur upon its tributary basins. If heavy rains prevail for a season in the northern tier of States, they are sure to record themselves in an impulse that reaches to the gulf of Mexico, and a February thaw is noticeable far south of the region of snow and ice.

Ignoring the complicated interactions which carry one so quickly into endless ramifications, and keeping resolutely in mind the broad and simple relations of rainfall and temperature, it is not difficult to interpret the story recorded by the Mississippi. In fact, simply from what has already been outlined concerning its chief tributaries, it is possible to build up, in its bolder features, the yearly record of the main river, and direct examination of the river confirms it.

Preliminary to such a synthesis of the Mississippi, two fundamental truths should be mentioned,—one common to all streams, and the other peculiar to this river. In the first place, as a river is the resultant of its tributaries, the times of its high and low water depend, not only upon the chronology of its tributaries, but as well upon their relative volumes both in high and low water. In the second place, the Mississippi is virtually created by the union at one point of three large rivers,—the Ohio, the Missouri, and the upper Mississippi.

The three most important branches of the main river, thus uniting at its head, naturally stamp their characteristics upon it to a very marked degree, and it bears these features through the entire course to the gulf. The large tributaries further south modify, but cannot control, the overwhelming influence of this triumvirate which presides over the Mississippi valley. To particularize still further, the Ohio should rightly, in a hydrological sense, be considered as the continuation of the main river, for, both in average and in flood flows, it fully equals the combined volumes of the Missouri and the upper Mississippi. It is only when the Ohio falls to low water that its effect is lost among the other streams.

It will be remembered that the Ohio is the first large tributary to raise its flood-wave to the highest point after the winter and spring rains set in. In February or March, as a rule, it pours an enormous volume of water into the Mississippi channel, which is already filling with the increasing flow from other tributaries, and establishes a condition of high water down the entire length to the gulf. Then does the Ohio reign supreme, and set the pace for the opening season of activity. As the Ohio flood subsides, the main river is held well up to high-water mark by the increasing flood-waves from the upper Mississippi and Missouri. Generally the crest of the former is the earlier to arrive, but occasionally their floods are coincident. One or both combine with the waning Ohio to raise the Mississippi, some time in March, April, or May, to its highest point for the year. In the mean time the lower tributaries, and notably the Arkansas, are not idle, but are doing their part toward maintaining the volume of the main river. Their *rôle*, however, is almost invariably subordinate to the three controlling rivers.

The two periods of flood characteristic of each of the large tributaries of the Mississippi have an important bearing upon the continuance of high water in the main river. By the time the first flood-crests of the upper Mississippi and Missouri have expended themselves, and sometimes coincident with them, the Ohio is discharging the summit of its second flood into the channel. Then occurs in June the highest stage of the Missouri, and about that time, but often in July, appears the yearly culmination of the upper Mississippi. Thus the chances are that, while one river is lessening its flow, another will be rising, and, in consequence, the tendency is for the main river to flow in strong volume until well into the summer. When June merges into July, the southern rivers have fallen, and the activity of the northern rivers is largely past. At this time the state of the upper Mississippi and Missouri determines the stage of the main river.

As the days pass, and the northern rivers follow the example of those further south, the Mississippi, which has been known to discharge two million cubic feet of water per second, may dwindle until its utmost volume is only one-thirteenth part as great. The barren slopes of the levees, standing high and useless on the bank, tell the tale of universal drouth upon the water-shed, and the steamboats struggle with the sand bars which obstruct the channel.

Toward the end of November the Mississippi shows the first signs of awakening energy, and rises moderately, owing to the late fall and winter rains in the south. Soon the Ohio again exerts its influence, chiefly through the two large rivers, the Tennessee and Cumberland, which monopolize the southern portion of its water-shed. As January passes, all the water-courses are rising, except those still locked fast in the snow and ice covering the northern States; and February once more sees the Ohio ready to dominate the entire Mississippi valley.

Thus is completed, in broad outline, the story of the yearly variations in the Mississippi. The river is a result; its tributaries are the cause. Viewed broadly, as has been necessary in this article, a general similarity of behavior is observed; yet each great feeder of the main river has its special cycle of alternations between high and low water; each great line of drainage has its distinctive features of flow. Were the secondary water-courses followed, the vast Mississippi water-shed would be seen covered by countless brooks and rivulets, each affected by local conditions, yet all obeying a few fundamental laws, which gather the waters as in the hollow of the hand, and pour them through a single channel to the sea.

Table of Rainfall and Discharge Data for the Principal Watersheds of the Mississippi System.

Watershed.	Rainfall.										Flow per Second.					
	Annual.		Spring.		Summer.		Autumn.		Winter.		Minimum.		Average.		Maximum.	
	Inches. Depth.	Cu. ft. per sec. per sq. mile.	Inches. Depth.	Cu. ft. per sec. per sq. mile.	Inches. Depth.	Cu. ft. per sec. per sq. mile.	Inches. Depth.	Cu. ft. per sec. per sq. mile.	Inches. Depth.	Cu. ft. per sec. per sq. mile.	Total in 1000's of cu. ft.	Cu. ft. per sec. per sq. mile.	Total in 1000's of cu. ft.	Cu. ft. per sec. per sq. mile.	Total in 1000's of cu. ft.	Cu. ft. per sec. per sq. mile.
Mississippi above mouth of Minnesota Riv. (19,500 sq. miles)	27·2	2·000	7·1	2·158	10·7	3·296	6·8	1·994	2·7	0·780	3	0·154	13	0·674	50	2·56
Minnesota (16,000 sq. miles)	28·0	2·061	7·0	2·070	11·8	3·476	6·6	1·944	2·6	0·772	0·5	0·031	7·6	0·474	[1]60	3·75
Upper Mississippi above mouth of Missouri Riv. (173,000 sq. miles)	34·7	2·555	9·0	2·650	12·8	3·769	8·2	2·415	4·6	1·355	25	0·144	118	0·688	550	3·17
Missouri (528,000 sq. miles)	19·6	1·443	6·1	1·796	6·4	1·885	4·4	1·296	2·7	0·795	25	0·047	94	0·178	600	1·14
Ohio (214,000 sq. miles)	43·1	3·173	11·9	3·504	11·8	3·925	8·5	2·503	10·9	3·210	35	0·163	204	0·953	1200	5·61
St. Francis (80,000 sq. miles)	41·3	3·041	12·4	3·652	10·2	3·004	8·6	2·533	10·3	3·033	[2]3·5	0·438	17	2·130	[4]36	4·50
White (28,000 sq. miles)	42·0	3·092	13·0	3·828	11·0	3·239	10·0	2·945	8·0	2·356	4·5	0·161	20	0·750	120	4·29
Arkansas (161,000 sq. miles)	28·3	2·082	8·6	2·518	9·3	2·748	6·3	1·864	4·1	1·207	4	0·024	48	0·300	250	1·55
Yazoo (13,000 sq. miles)	53·3	3·924	17·8	5·239	10·9	3·222	8·9	2·621	15·7	4·615	[3]5	0·384	35	2·749	[4]80	6·15
Red (97,000 sq. miles)	38·3	2·798	11·5	3·386	10·2	3·019	8·4	2·485	8·2	2·400	3·5	0·036	50	0·515	180	1·86
Mississippi above its mouth (1,259,000 sq. miles)											175	0·139	664	0·528	1800	1·43

[1] Probably much exceeded at times.
[2] Obtained from a comparison of the Yazoo and White.
[3] Derived chiefly from gaugings by Captain Willard; checked by comparison with the White.
[4] Result chiefly of a comparison with the White, allowing for differences of rainfall and topography.—Somewhat uncertain.

From an article by James L. Greenleaf, C. E., upon the "Hydrology of the Mississippi," published in the issue of the *American Journal of Science* for July, 1896.

THE CURE FOR CORROSION AND SCALE FROM BOILER WATERS.

By Albert A. Cary.

GENERALLY speaking, no important subject in steam engineering is receiving less intelligent attention from steam users to-day than the choice of feed-water for boilers and the evils resulting from a bad selection. If absolutely pure water were available from natural sources for boiler use, a consideration of the subject would be uncalled for, but, unfortunately for steam users, such is not the case, and therefore it becomes the duty of owners and operators of steam plants to inform themselves, at least generally, on this subject, that they may reduce their operating expenses by saving fuel and time in cleaning, and by lessening materially the necessity for boiler repairs.

Owing to the fact that water is the greatest of all known solvents, all natural waters contain more or less impurities, and therefore, in making a selection for boiler purposes (if a selection is possible), it is not a question of obtaining a pure water, but of choosing one which contains such impurities as will give the least trouble, or else one containing such impurities as will yield most readily to purifying treatment. If more than one source of supply is available, it certainly will pay the steam user to seek the advice of an experienced expert, before adopting either. Many, most erroneously, infer that, if they have a good drinking water, it must necessarily be good for boiler use. This was well illustrated to me a few years ago, when I found a large steam plant using water from the town supply and having no end of trouble from hard deposits of scale in their boilers. This plant is located on the bank of a large stream, but its water is generally muddy and turbid, presenting an unattractive appearance. A little investigation proved that this stream water was far superior to the town supply for boiler purposes, and the next step was to make provisions to clear it of its suspended matter. I found that the ground on which the plant was built was almost a pure sand, extending to the river-bed. I then had a number of wells driven just outside of the boiler-room. They were rapidly filled from the river, through this natural sand filter, giving a good, almost clear feed-water, causing very little trouble in the boilers.

Probably the purest water obtainable is rain water. Many may think that this should be entered here as an exception to my sweeping statement that no pure water is obtainable from natural sources. I am sorry to say that facts will not support this exception, as rain water is always found to contain more or less impurities, and the same may be said of hail, snow, mist, dew, or hoar frost. All of these forms of water find in the atmosphere gases and fine floating matter which they eagerly appropriate and carry with them as they fall. Of course, a greater proportion of impurities is found in the neighborhood of large towns and manufacturing centers. Probably one of the most careful researches concerning the purity of rain water was made by the rivers pollution commission of Great Britain. It reports the following as the average obtained from the examination of seventy one different samples of water collected at a farm at Rothamsted, England.

Total dissolved solids............	3.95	parts in 100,000.
Organic carbon..................	0.099	"
Organic nitrogen................	0.022	"
Ammonia......................	0.050	"
Nitrogen as nitrites and nitrates...	0.007	"
Total combined nitrogen.........	0.071	"
Chlorine	0.063	"

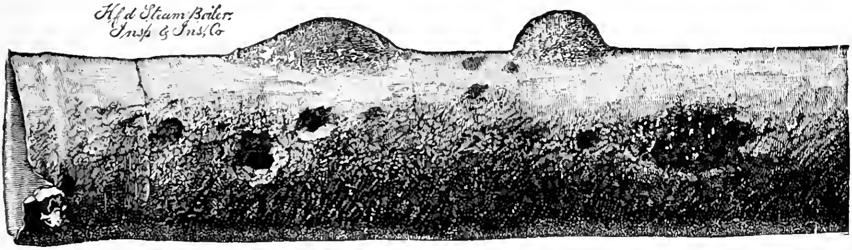
This list by no means includes all the impurities. Oxygen is often found, and also, frequently, sulphurous and sulphuric acids (derived from the combustion of certain coals). Snow is particularly adapted to absorb these acids from the atmosphere; thus, Sendtner found snow freshly-fallen, in Munich, to contain .7 parts sulphuric acid per 100,000. On the following day it contained 1.76 parts; after ten days, 6.22 parts; and after sixteen days, 9.18 parts.

One of the most available places to collect rain water for industrial purposes is the roof of a building. Roofs are generally covered with dust, soot, and other dirt affecting the purity of the water materially; therefore the first rain that falls (which not only cleans the roofs, but also washes out the air to a considerable degree) should be allowed to run to waste. There are devices on the market made to accomplish this result automatically. Notwithstanding all I have said regarding the impurities in rain water, it will be found to be much purer than water obtainable from any other natural source, and, therefore, some steam plants, in which much trouble follows the use of bad feed-water, might substitute, at least partially, rain collected from the roofs.

In Switzerland there are lakes fed principally from the melted ice and snow of the mountains, and in Scotland there is a lake of wonderful purity from which the water-supply of Glasgow is obtained. These waters would be called practically pure, if judged by the residue left behind after evaporation, but, notwithstanding, they are giving a great deal of trouble in boilers, due to excessive pitting.

Pitting may be described as a corrosion occurring in small spots on a boiler tube, flue, or shell (in contradistinction to a general corrosion which wastes away an extended surface). This pitting action is often very destructive, frequently burrowing holes through a boiler sheet or tube, as though it had been drilled. Pitting has sometimes been attributed to poor material used in construction, the theory being that weak spots exist and are attacked by corrosive agents (found in the water), yielding thereto more readily than the perfect part of the material. There is little doubt that such imperfections would facilitate the action, but this explanation falls short of a satisfactory answer, as it can be fitted to but very few cases.

Careful experiments by Prof. Crace Calvert, repeated by A. Wagner, Scheurer Kestner, Meunier Dolifus, and others, show that pitting occurs when gases are found dissolved in the water, oxygen and carbonic acid gas being the most active destroyers, especially when present together. Gases are very soluble in water, and should be looked for as carefully as dissolved liquids and solids. The waters of the Swiss and Scottish lakes referred to contain a considerable quantity of the gases named above and the serious pitting is due to their presence.



A TUBE PITTED BY PURE WATER.

Considerable air is found dissolved in water, and it is a curious fact that, when thus in water, its original proportion of 1 volume of oxygen mechanically mixed with 4 volumes of nitrogen is changed (owing to the greater solubility of the oxygen), becoming 1 volume of oxygen to $1\frac{87}{100}$ volumes of nitrogen. With the oxygen thus increased the corrosive power of the changed air is accordingly greater. It has been found that air and gases are expelled by thorough boiling.

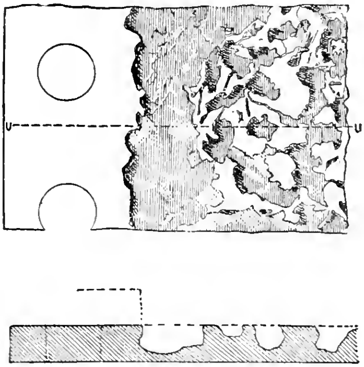
The destructive action of water having a temperature close to the boiling point is doubtless due to the fact that the contained air or gases have not been removed. Much trouble from pitting has occurred in low-pressure house-heating boilers, owing to insufficient boiling and a circulation too weak to remove the bubbles of gas that attach themselves to the internal surfaces of the boiler. This is also often the case in feed-water heaters and connecting pipes. Cast iron has proved itself superior to wrought iron and steel in resisting this corrosion.

I recently had my attention called to a heating boiler in New York city using Croton water from the city supply. This is an exceptionally good water for boiler use, and therefore it surprised the owner and contractor to find the tubes badly pitted less than a year after the boiler was started. New tubes were put in, but the same bad pitting was found in them a year later.

Lack of good circulation in all parts of the boiler might account partially for this trouble, but further inquiry brought out the fact that, as soon as the weather grew warm, this boiler was put out of service and the water was left standing in it. Then the dissolved air and gases had their opportunity for destructive work without interruption by circulating currents. When such boilers are put out of service for the summer, no water should be allowed to remain in them. They should be blown off while warm, well cleaned, and thoroughly dried either by wiping or by heat. To accomplish this by the latter method, pans of burning charcoal are introduced into the boiler, or a very light fire of paper or shavings may be started upon the grate.

It is not an easy matter to explain the action of these gases producing pitting in a steam boiler. Why is it that isolated spots are attacked, while the surrounding metal is apparently unaffected? When water is slowly heated in open vessels, bubbles of gas or air are seen clinging to the sides or bottom, and, if there is a crack or similar imperfection in such a vessel, it appears to present a wonderful attraction for these bubbles, more collecting there than elsewhere. Again, these bubbles seem to place themselves with a very fair degree of regularity, as far as their distance apart is concerned, and, if any certain area is cleared, that space seems to have a special attraction for new ones. Considerable agitation fails to remove these bubbles, which cling tenaciously to their selected places. In boilers there is little doubt that these bubbles contain gas in a favorable condition of moisture and temperature to act rapidly on the metal beneath. After eating a little pit and exhausting their oxygen, they leave behind, in the pit, oxid of iron, which occupies more volume than the original iron acted upon. In consequence, the pit is more than filled, and a little boil-like excrescence appears. Expansion and contraction break up this oxid deposit, thus preparing this same spot to attract the next little bubble of gas, which, in turn, does its work, and this action continues, until a hole is corroded entirely through the metal.

Sometimes a considerable number of these pits occur very close to each other, giving the metal almost a honeycomb appearance, but this is less frequent than a scattered form. As a remedy for this trouble, probably nothing is more effective than the deposit, in a boiler, of a slight lime scale on which the corrosive agent contained in these



A HONEYCOMBED PLATE.

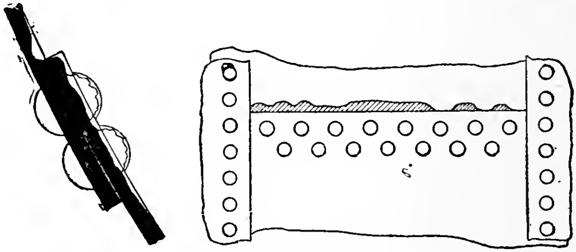
bubbles can exhaust itself. If this slight deposit cannot be effected by using the regular feed, or natural water available from some other source, a solution of milk of lime can be fed into the boiler along with the feed-water, and this will soon form the required internal coating.

Some have attributed pitting to electrolytic action set up between the impurities in the iron (occurring at small points) and the iron of the boiler itself; the iron, being electro-positive to the impurities, gradually disappears, while, of course, the impurities remain unaffected to further this destructive action. If this is the correct explanation, zinc should be suspended in the boiler and connected most carefully with the boiler shell by copper wire, when the zinc (which is electro-positive to iron) will disappear gradually, and, in so doing, will protect the iron. The writer has never adopted this theory, and his success in overcoming pitting troubles in boilers, working on the assumption that this trouble is due to the presence of gases in the water, goes far with him to support the correctness of that theory, which has also been confirmed in many other ways.

There is one other form of corrosion which limits its action to certain local spots, or, rather, lines, in a boiler, known under various names, such as grooving, channeling, and furrowing. This subject is almost foreign to this article, which considers merely boiler waters and the troubles resulting from their use, and it might be placed more properly under the heading of bad design; but, as it facilitates greatly the corrosive action of bad feed-water, a few words will be of interest here.

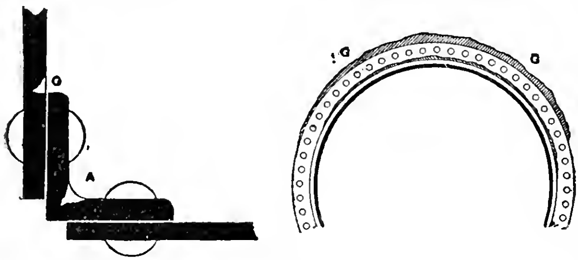
Grooving in boilers nearly always occurs at such parts of the metal as are subjected to an excessive alternate bending backwards and forwards, as the pressure and temperature of the boiler changes; less frequently, it is due to bad or excessive caulking of the seams or joints.

When the metal is continually bent backwards and forwards, it sooner or later develops a crack, which opens its skin, thus exposing an inner line of unprotected metal to any corrosive agent in the water. After this exposed surface is attacked, an oxid of iron or other formation covers the metal and in a great measure protects it from further corrosion, but, as the flexing continues, the protecting coat soon cracks off, allowing the corrosive agent to attack a newly-exposed line of metal immediately below the original surface, which continues until the groove is developed and finally the boiler becomes unsafe, which condition has frequently been followed by disastrous explosions. This excessive bending action in the metal of boilers is due chiefly to bad design. Either too great rigidity is found immediately adjoining a flexible part, in which case the latter is subjected to buckling under the great strains to which boilers are necessarily subjected, or else some part is not sufficiently stayed or strengthened to prevent a considerable change in shape from taking place under the pressure carried by the boiler. Both extremes can be avoided by a careful designer.



GROOVING AT A LAP, CAUSED BY BENDING.

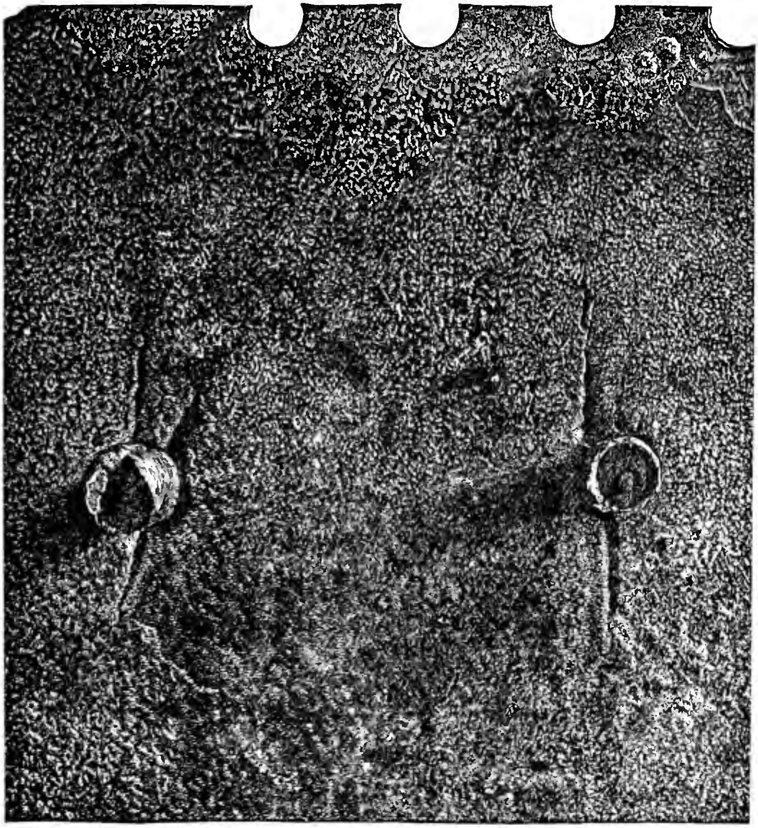
We often find grooving next to a heavy riveted seam and nearly parallel to it, and it is also found next to heavy reinforcing rings and saddles used to strengthen the shell where holes have been cut. Where the flat surfaces of boilers are stayed too rigidly by gussets, braces, or other forms of stays, we find grooving near their fastenings. This occurs very frequently in various forms of flue boilers. Such trouble can be stopped by altering the construction of the boiler, introducing more flexibility where it is needed—sometimes a very difficult matter.



GROOVING OF A TUBE ATTACHED BY AN ANGLE-IRON.

As an example of too great flexibility, we sometimes find boilers having heads insufficiently stayed, allowing considerable bulging action when the boiler is under pressure. This produces alternate bending at the bottom of the curve of the flange by which the head is joined to the cylindrical shell. This bending soon develops a crack, and then the grooving follows. In some cases where insufficiently-stayed flat surfaces are riveted to angle irons, the flexing takes place in the bend of the angle iron, soon developing the troublesome crack. This also occurs occasionally where large flues are attached to the end-heads of boilers with angle iron. The trouble from insufficiently-stayed surfaces can usually be remedied by the careful placing of new stays, sufficient to prevent undue distortion of the part affected.

The other trouble is generally due to the use of continuous straight riveted flues, which, in service, are highly heated along their upper part, while their bottom part is comparatively cool. This produces an



CORROSION AROUND STAYBOLTS.

inequality in the lengths of the two parts, causing what is known as "arching" of the tube, from which necessarily results bending in the connection between the end of the tube and the flat ends of the boiler, which in turn is followed by grooving. In such cases flexible flues, the corrugated flue, for instance, should replace those having the ordinary lapped and riveted seams.

I have spoken of grooving following bad or excessive caulking. By such work the skin of the metal is broken, and the sheet is more or less deeply scored near the edge of the lap seam. Corrosive agents soon concentrate their efforts along such places, and leave behind the furrow.

When a crack appears in the metal of a boiler, it does not always follow that it is going to develop into a groove or furrow; that depends entirely upon the character of the water used. Should no corrosive agent be present, the crack would often remain so small as to escape the notice of an inspector; but, as the bending continues, the crack generally grows deeper, until it becomes dangerous. The width and depth of the grooving depend entirely upon the amount of corrosive matter held by the water, both increasing together.

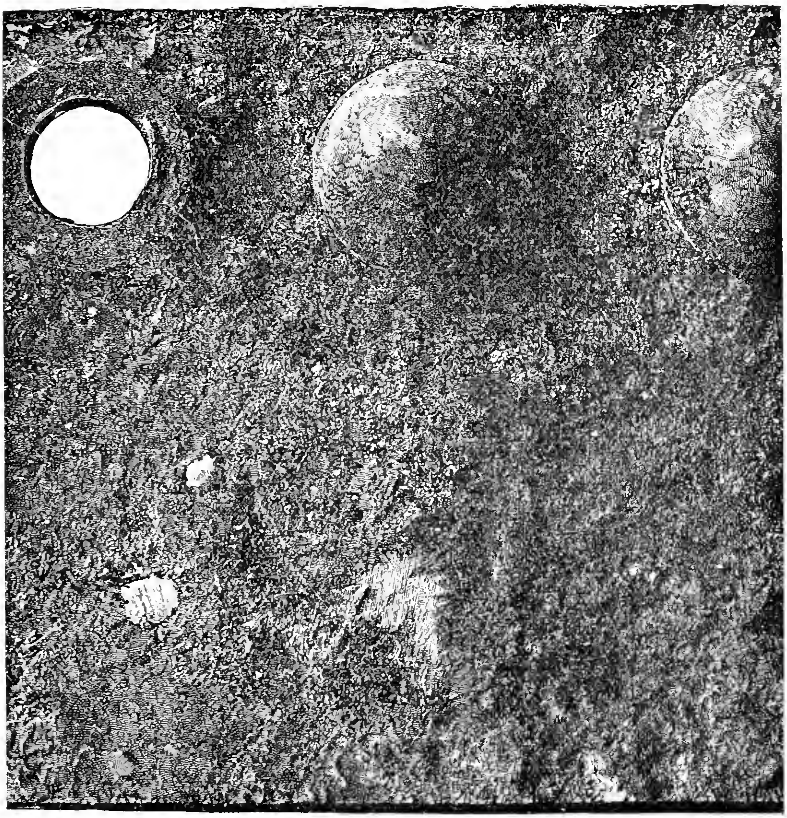
We have now considered the two special and marked forms of corrosion, and next come to the most usual form, known as general corrosion. This is simply the wasting away of the boiler parts. It is most erratic in its actions, occurring sometimes with a fair degree of uniformity throughout the entire surface of the boiler in contact with the water, but most frequently in patches, small or of considerable area; but in such cases there is so gradual a merging from the corroded to the solid plate that it is impossible to define the exact limit of the deterioration. This is a distinctive feature of general corrosion.

Sometimes we find a band of more or less width etched around the boiler shell, its position coinciding with the "water line" or upper surface of the water in the boiler, while its width is determined by the rise and fall of the water-level as allowed by the water tender.

Rivet-heads are often found wasted away to a dangerous extent, and often in such cases the metal sheet around this head is found corroded, but in such a manner as to leave a circle of metal intact immediately beneath the head of the rivet, presenting such an appearance that an inexperienced inspector would easily mistake this "boss" for a part of the head itself, and thus miscalculate the dangerous extent to which the rivet had been corroded. Braces and stays are often found badly "eaten away," and no part of the boiler seems to escape.

General corrosion does not always stop at the surface of the water in the boiler; we sometimes find it occurring on the surfaces in contact with the steam, and even in steam pipes leading from the boiler.

Frequently corrosion and scaling occur together in boilers, and, when a corroded place is thus hidden, it becomes all the more dangerous, as the man inspecting the boiler is apt to pass it over, and, under a feeling of false security, nothing is done to prevent further corrosion. Fortunately, in many cases the scale which covers the corroded spot cracks, and "bleeding" occurs along these lines, this coloring coming from the iron rust,—an indication of what is going on beneath.



CORROSION DUE TO CONTAMINATED WATER.

The only safe way to determine the extent of corrosion is by drilling holes through the plate. To show how easily one may be deceived in attempting to obtain this information in any other way, I might describe the experience of a certain engineer who found the corrosion in a shell extending to the edge of a lapped and riveted joint. He first measured the thickness of this plate from its surface, along its edge, to the surface of the adjoining plate. To his surprise, he found the plate, by this measurement, to be of its original thickness, notwithstanding the very apparent corrosion. Investigation afterwards showed that the adjoining plate was also corroded to a depth equal to the depth of corrosion in the first plate (which accounted for his surprising measurement), while the wasted rivets appeared the same as originally, for the reason already given.

Many explanations are offered as to the cause of boiler corrosion in all of its peculiarities, and probably none more frequently than the electrical theory. This is especially true among our marine friends. I have already alluded to this theory, following my remarks on pitting, and, although not wholly converted to it, I believe that this article would be incomplete without an attempt to make it clear. I certainly do not wish to deny that electric action occurs in boilers, similar to that occurring in a voltaic cell. This has been proved beyond question by the use of a delicate galvanometer, but the strength of the current thus generated is certainly very seldom sufficient to cause so vigorous wasting away of boiler parts as is often found. For example, a current is generated by the difference in temperature between the top and bottom of certain internally-fired boilers, or between different kinds of metal used in and about a boiler, such as a steel shell and iron or brass tubes or composition fitting.

Again, we find a current set up between different parts of the same metal, where a certain portion is sound and homogeneous, while another is poorly made, containing impurities common in bad iron.

In such cases and many more conceivable ones, our electrical friends tell us, two of the parts considered are electrically opposed, one becoming electro positive and the other electro negative, the former wasting away, while the latter remains scarcely affected. They claim, further, that, if zinc be placed in the boiler, a much stronger current is established between it and the shell than exists elsewhere, and therefore the zinc becomes electro-positive to the entire shell and protects it at its own expense as long as this current is amply strong.

Being now led to the subject of applying zinc in boilers for their protection from corrosion, and this being a practice largely followed (especially in marine boilers), the principles of its application and working should be clearly understood. It will then be seen that zinc is by no means applicable to all cases, and may even do more harm than good when misapplied. The electrical theory just described need not be considered in this connection.

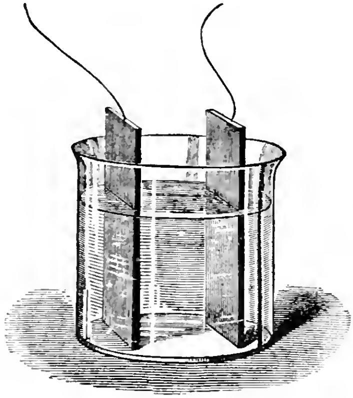
When zinc is placed in a boiler, it must be remembered that we are trying to construct a huge voltaic cell (or electric battery, as many popularly term it). Let us now examine a simple voltaic cell, and the requirements for its successful working.

We find a glass jar nearly filled with a liquid in which are placed two plates, the greater part of which are immersed. At the dry end of these plates copper wires are found, securely attached.

The liquid into which these two plates are plunged is always composed of two or more elements, and, when a voltaic current is made to pass through it, a separation of the elements takes place.

This process of decomposition by the electrical current is called electrolysis, and the liquids thus split up are known as electrolytes.

All liquids are not electrolytes; many oppose the passage of the current so effectively that the plates are practically insulated, and then, of course, no decomposition can occur. Pure water is a poor conductor of electricity, and for that reason we never find it used alone in voltaic cells; a little sulphuric or other oxidizing acid is added, or some of the metallic salts, making good electrolytes.



A VOLTAIC CELL.

We now have before us the essential requirements for the construction of a voltaic cell, but, before assembling the parts in order to study the working, I call attention to the result that follows the passage of a current of electricity through water. Let us suppose that we have an available wire condutcing a current of electricity. Let us cut this wire, and place the two ends thus obtained in water. As water is a poor conductor, we had better add a little sulphuric acid, which will increase its conductive power considerably. We now observe that bubbles of gas are rapidly forming on the immersed ends of our wire; should we collect these bubbles as they rise and escape from the liquid, we would find them to be simply oxygen and hydrogen (the constituents of the water). The oxygen will be found collecting on the wire through which the current enters the water (known as the positive pole), while the hydrogen will collect on the other wire (or negative pole). If such a decomposition does not take place, the fluid does not conduct the current.

For our next step, we will construct a voltaic cell, and, in order to produce a rapid chemical action, both on the plates and in the liquid, we will make our solution of sulphuric acid somewhat stronger than before, and will select zinc for the positive plate and wrought iron for our negative. If the zinc were perfectly pure, no action would take place on immersion in the solution; but commercial zinc is never pure, and, as we are supposed to use this, we find that our zinc plate is attacked the moment it is placed in the liquid, and, as it dissolves away, a large quantity of hydrogen bubbles are given off from the surface of the metal. Next let us immerse our iron plate; we find at once that this is also attacked, hydrogen bubbles rising from its surface as the metal wastes away.

Next let us connect the two copper wires attached to the upper (or dry) ends of these plates; we note at once a change of conditions. The bubbles of hydrogen will still be seen to come from the iron plate, but the plate will not be dissolved. The zinc plate, however, will gradually disappear, but, as long as any part of it remains in electrical connection with the iron, the latter will be protected at the former's expense. The zinc is said to be electro-positive to the iron, or, as some of our chemical friends express it, it is chemically more powerful than the iron. I might call attention to a common practice of protecting iron from rust and corrosion by coating it with a thin film of zinc. This is known as galvanizing; it depends largely upon the principles just described for its successful working.

It is almost unnecessary now to state the reason for the wasting away of the positive plate. It is simply that, as water is decomposed by the passage of the current through it, the oxygen is attracted to the positive plate, and, as electrolytic oxygen (or ozone) is very active in its attack upon metals, we find them more or less rapidly wasting away. Where sulphuric acid (H_2SO_4) is used, we find, after its decomposition, that the hydrogen (H_2) has been attracted to the negative plate, while the corrosive sulphur and oxygen (SO_4) have been attracted to the positive plate.

We can now readily understand the action of zinc in boilers. We might, for example, suppose our iron plate, which we have been using in our experimental cell, to be of sufficient length to be bent into a cylinder in which to suspend the zinc plate by means of a copper wire. This done, we can immerse these in our electrolyte, and we have our cell complete, as before, and also a miniature boiler, without heads.

From this explanation it will be understood that zinc can be used successfully in boilers only when certain conditions preëxist. Some solution must be found which will make a good electrolyte. This condition is often satisfied by the presence of free acid. Sea water makes a good electrolyte, and, in consequence, we find zinc in extensive use in marine boilers. The writer knows of a case where salt was added to a fresh feed-water, in order to make it a good electrolyte. Many other solutions are found in feed-waters, making them good conductors. Another condition of paramount importance for the successful application of zinc is a sure and lasting electrical communication between the zinc and the shell of the boiler. A copper wire or an iron supporting piece attached to the zinc is generally used for this purpose. One can easily understand that, the moment this electrical communication is broken, the zinc ceases to protect the boiler, and corrosion wastes away both the boiler and the zinc.

To secure this electrical communication much time, thought, and money have been expended; yet we constantly hear of failures in the use of zinc due solely to interruption of the communication.

Zinc plates are often suspended by means of iron straps or clips bolted to them, and are liable to become separated soon by the corrosion on the surface of the zinc; the voltaic current is thus weakened by the resistance introduced between the iron and the zinc, and finally it ceases altogether. Probably one of the best devices invented to overcome this trouble originated with Hannay, who called it "the Electrogen." It consists of a zinc ball having the copper conductor cast through its center; in the process of making, the copper is fused, becoming mixed with the zinc and forming an actual brass. The ball is well hammered, at a certain temperature, thus condensing the metal and insuring its long existence. When the electrogen is suspended in the boiler, the free end of the copper wire is firmly soldered to the shell, and thus a positive electrical contact is attained,

Thus far we have considered the use of zinc for preventing corrosion in boilers; now we want to know how it affects scale. This more properly should be considered after investigating the properties of the different boiler scales, but, to allow the answer to follow the question (which naturally appears here), I will say that there are certain scales, such as those formed by the precipitation of carbonate of lime and carbonate of magnesia, which are not very compact, but open, porous, and easily penetrated by the water. The water easily reaches the shell through them, and, when it is decomposed by the voltaic current, the hydrogen bubbles, which appear on the iron, soon form a film of the gas, which interposes between the plate and the scale; then follows the flaking off of the crust, piece after piece, until the greater part is removed.

Other scales, such as those formed of the sulphate of lime, are hard, tenacious in their hold on the iron, and totally impervious to the water. Under such conditions this necessary film of hydrogen gas will not form between them and the boiler shell, so that they adhere to the firm metal beneath, which has been protected from corrosion by their presence.

None but the purest zinc obtainable should be used in boilers. All commercial zinc contains more or less impurities, and these may become a source of absolute danger when present in any appreciable quantity. Lead is often found, and, after the zinc has wasted away, the remaining lead and the iron composing the boiler become an electric couple, the shell being the electro-positive plate, which begins to waste away as the oxygen bubbles form upon it, while the lead, of course, remains unaffected by the hydrogen.

Electric batteries have been used to accomplish results similar to those obtained with zinc in the boiler, and with equal success. With this arrangement, the two wires from the cells were led to the boiler, and one was attached carefully to the boiler shell. The second (the positive-pole of the battery) was carried inside of the boiler and terminated with a metallic plate. The action which follows has already been described in the case where the cut ends of a wire, conducting an electrical current, were plunged into a vessel of water.

A concern in Cardiff (Wales) has gone even further than this, supplying the current from a dynamo, and it claims to obtain superior results by reversing the current periodically, so as to change the immersed or suspended plate from positive to negative, and then back again. It claims that it makes the suspended plate electro-negative to the shell to facilitate the disintegration of the scale and hasten the mechanical action of the hydrogen in flaking it off, and also to prevent the polarization of the shell and tubes. This latter process is somewhat questionable, and the writer, before accepting it as good practice, prefers to see these claims proved by more extended use.

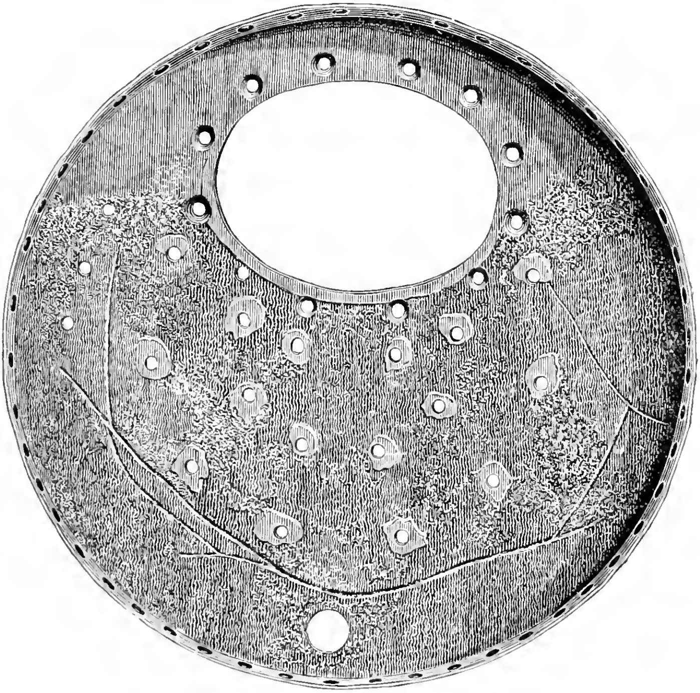
Having considered electrical action in connection with boiler corrosion, now it will be well to find what is contained in boiler water to produce corrosion. We have already considered the presence of gases in boiler water, and their very destructive effects. When corrosion is found in boilers, especially if generally distributed, free acid in the water is looked for first. This acid may be derived from a great variety of sources. I have already spoken of the sulphuric acid absorbed by rain water and snow, from the atmosphere. When we come to the consideration of scale-producing impurities contained in feed-water, we shall find that chlorid of magnesium is often present.

At all temperatures found in boiler practice, this troublesome salt decomposes, as shown in the following chemical formula :

$$\underset{\text{Magnesium Chlorid.}}{Mg\,Cl_2} + \underset{\text{Water.}}{2\,(H_2\,O)} = \underset{\text{Magnesium Hydrate.}}{Mg\,H_2\,O_2} + \underset{\text{Hydrochloric Acid.}}{2\,(H\,Cl)}$$

The hydrochloric acid (or, as it is sometimes called, muriatic acid) is vaporized and passes off with the steam ; thus its destructive action takes effect, not alone in the boiler, but in the steam pipes, valves, cylinders, etc.

Boilers supplied with water from mines are often badly corroded by the large quantities of saline constituents, especially sulphates, derived from the oxidation of pyrites and other sulphids. When calcium carbonate is absent, free sulphuric acid often exists in these waters, accounting for the destructive action, more or less energetic, which follows its use. Certain springs and streams in volcanic districts are found to contain free sulphuric acid. Sulphur dioxid occurs in vol-



CORROSION FROM MINE WATER.

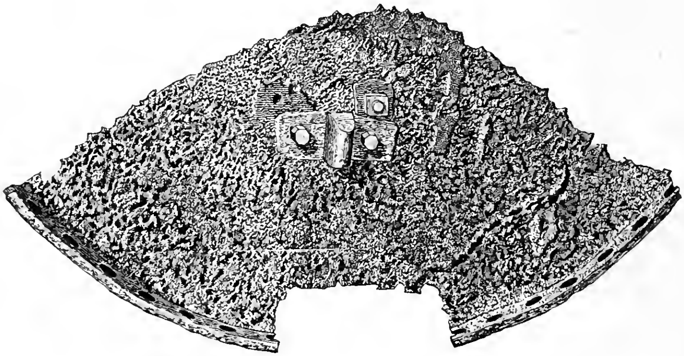
canic gases, and these, when dissolved in water, gradually absorb oxygen from the air and pass into sulphuric acid. A notable example of this kind is found in South America, where the Rio Vinagre (which received its name on account of the acid taste of its water) contains free sulphuric acid from the volcanic springs which feed it.

Streams following through manufacturing districts are often found to be acid, with the refuse poured into them from dye works, galvanizing shops, chemical factories, etc. Such waters should be very carefully examined before being used in boilers, and the acid should be neutralized thoroughly by treatment with proper alkalies, or, as proper treatment is difficult on account of variable composition, water from another source should be obtained, if possible. I know of cases where boilers have been very rapidly destroyed by use of such water.

CORROSION FROM MINE-WATER. SECTION OF THE HEAD SHOWN ABOVE.

Vegetable acids, which corrode the boiler parts, are often found in waters from swamps or bogs. Soft waters (containing little mineral matter) seldom pass any considerable distance from their source before entering a district where vegetation exists, and then, on account of their great solvent power, they readily dissolve the peat or other organic matter found in the woods and fields. It is true that these are but feeble acids; nevertheless they attack the boiler plates, and the slimy nature of the salts produced by such attack causes them to form an objectionable incrustation. As oxygen also is usually present in these waters, pitting is liable to occur, and the vegetable acids seem to supplement and assist in the corrosion, after the manner of carbonic acid, the action of which has already been described.

There is another source from which free acid is sometimes introduced into the boiler feed-water,—one not generally known. Many



CORROSION FROM SWAMP-WATER.

plants in this country are using kerosene in their boilers for the purpose of removing, or preventing, incrustations. Serious corrosion has often followed the use of this oil, and it has puzzled many thinking men to account for it.

Kerosene, produced by a series of distillations from petroleum, is at first a bluish, turbid liquid with a very strong odor. The odor, color, and turbidity are removed by treatment with sulphuric acid, which settles down with the impurities as a heavy black liquid, and is withdrawn to the sludge acid tank. The oil is next washed with water, treated with caustic soda to neutralize the acid, and again washed with water. Next, in order to volatilize any traces of light oils present, the oil is agitated by pumping air through it by a spraying process. In this way the brilliant white illuminating oil with which we are familiar is produced.

Unfortunately, for many who have seriously injured their boilers, this process (though amply able to accomplish the desired results) is sometimes conducted carelessly, so that some acid remains. The oil, when in the boiler, volatilizes and passes off with the steam, while the acid, which remains behind, concentrates (as additional oil is fed to the boiler), and corrosion begins.

I know of certain plants that have experienced this trouble, where use of kerosene continues, but, by alternating it week by week with an alkali (such as the carbonate of soda), all trouble is avoided.

Another source of trouble in boilers is the presence of oil and grease which have been used for lubricating purposes. These accompany the condensed water, formed from the exhaust steam, so often returned to boilers. I have also known of cases where those in charge of boilers, ignorant of the different compositions of the various oils, have actually fed into boilers some of the most dangerous oils, for the purpose of removing and preventing incrustation.

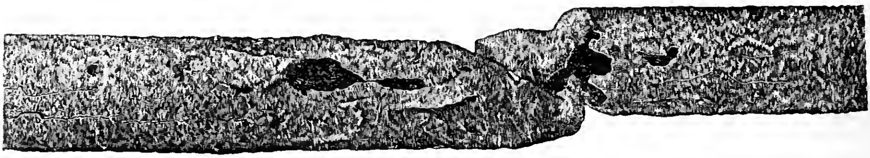
It should be remembered that many of the lubricants used on engines, pumps, etc., are compound oils,—that is, mineral oils mixed with some one or more of the animal or vegetable oils for the purpose of increasing the viscosity. These admixtures are known as "fatty oils." and it is well known that, after exposure, they often become rancid,—in other words, undergo partial decomposition, producing free fatty acids which exert corrosive action on metal surfaces.

We have now traced the principal sources from which the free acids found in boiler waters are derived. It is, perhaps, an unfortunate fact that acids never cause a boiler to prime or foam, and thus give notice of their presence, as do some of the alkalis; I once heard a man in charge of a boiler plant remark that, for the reason just given, he thought a little acid in a boiler a good thing. This man shortly afterwards nearly ruined a boiler by feeding in muriatic acid for the purpose of removing its scale.

The presence of acid in a boiler may sometimes be detected by drawing a sample in a glass from one of the gage-cocks and immersing in it a slip of blue litmus paper. This paper may be obtained at any drug store. A more delicate test may be made by introducing in each boiler about two ounces of phenol-phthaleine. If no acid is present, the water in the gage glass becomes faint pink in color, but, when there is acid, this color weakens, and may even vanish entirely. Of course, blowing off or leakage about the boiler will also cause this color to fade away; otherwise, it would remain in the boiler as a splendid indicator of the presence of free acids.

Whenever boiler water is found to contain free acid, it should be treated with an alkali, such as the carbonate of soda, and the quantity used should be only in slight excess of what is actually needed to completely neutralize the acid.

Corrosion in boilers has also been traced to the use of water contaminated with sewage and the drainings from privy vaults. The presence of ammonia in some form (probably as sal ammoniac) seems to be responsible largely for this corrosion. When sal ammoniac is concentrated to any great degree, it is a very active corrosive agent.



A TUBE CORRODED BY CONTAMINATED WATER.

Before leaving this branch of the subject,—the gradual wasting away of boiler parts,—it is well to consider the action of rusting. Iron in all its forms has a great affinity for oxygen, combining with it under nearly all conditions and forming what is commonly called rust. In some cases this rust is seen to "penetrate" the iron in spots, while in other cases the whole metal seems to change from its simple metallic state into a red, yellow, or brownish substance, which crumbles away on being handled.

In the ordinary course of corrosion, it is found that oxygen combines with iron in two different proportions, one forming the protoxid of iron, in which one atom of oxygen combines with one atom of iron ($Fe\ O$), and the second forming the sesquioxid of iron, in which three atoms of oxygen combine with two atoms of iron ($Fe_2\ O_3$). Should we expose a bright piece of iron to a damp atmosphere, it would be covered eventually with a bright red coating of rust. This is the sesquioxid of iron ($Fe_2\ O_3$). Removed from dampness, and under cover, the rust soon turns from red to brown. Why is this? Simply because this sesquioxid of iron has given up its third atom of oxygen to the iron, forming a new molecule of the protoxid at the expense of the metal. Now, if this be returned to the damp atmosphere, the red oxid will appear again (indicating the sesquioxid), and under alternating conditions this kind of action continues until the whole plate is affected or "eaten away."

The second paper on this topic, which will appear next month, will treat of the causes and remedies for scale and incrustation in boilers.

Thanks are due to the courtesy of the Hartford Steam Boiler Inspection and Insurance Co for the use of many of the cuts used in illustrating this article.

STANDARDIZING THE TESTING OF IRON AND STEEL.

By P. Kreuzpointner.

II.

IN the previous article on the subject under discussion it was endeavored to point out, numerically, the value and merits, or demerits, of various test-sections as measures of the quality of steel for structural purposes. In the present article it is sought to emphasize and strengthen the conclusions reached, numerically, by graphic illustrations of the phenomenon taking place in the steel, when under tension, of which phenomenon the numerical results are the exponents.

If thus we can picture, as it were, the flow—or degree of viscosity, which is the same thing—of a given piece of steel, we can form a clearer perception of the reasons why different test-sections give different results, although the material from which the test-pieces were taken is the same in chemical and physical properties in every respect. Incidentally also, a graphic illustration of the causes producing a variety of results with the same material, due to variations in test-sections, is, of course, an argument in favor of uniform methods of testing.

As already stated, iron and steel flow under pressure. This being so, it follows that this flow must be subject to certain laws.

Water runs freest through a straight, smooth pipe. If there are bends and shoulders, it will not flow as freely at these points. But, where there are no obstructions, the water will still flow more freely in the middle than on the sides or walls of the pipe, as a river flows faster in the middle than on its shores.

If we substitute a viscid material for the water, we find that it will not flow through a pipe without pressing or pulling, and even then it will stick at obstructions, or, if the orifice is too narrow, will not flow at all, but will clog up the pipe so that neither pushing or pulling will move it. Now, these conditions seem to apply to iron and steel when they are set in motion by pressure. They are springy, resilient substances, within certain limits. When, under sufficient pressure, they begin to flow, they flow more freely in a large, unobstructed mass.

Shoulders and fillets hinder and retard the flow, as an obstruction in a pipe hinders the flow of water. Flow is very sluggish in narrow pieces, and more free in especially long, but wider, pieces.

Thus it appears that the same law that governs the flow of viscid materials governs also the flow of iron and steel.

This law, then, must govern the size and shape of our test-piece, and, the more we depart from this law, the more faulty and unreliable the results.

Figures V, VI, VII, and VIII are sketches made from samples of boiler steel test-pieces prepared in a certain way—to show the flow of the metal. For convenience's sake, one half of each sketch is left blank, and the scriblines 1 to 11, which were drawn on the highly-polished test-pieces, are shown only on the blank half, but may easily be transferred mentally to corresponding positions on the other half. Thus 1^1 corresponds to 1, and 11^1 to 11.

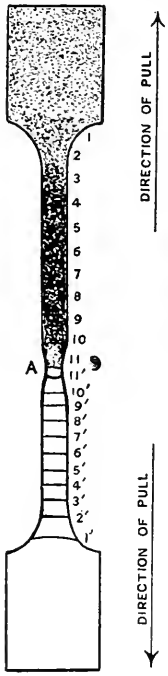


FIG. VI.

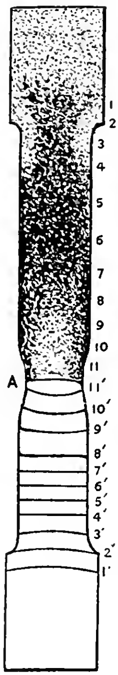


FIG. V.

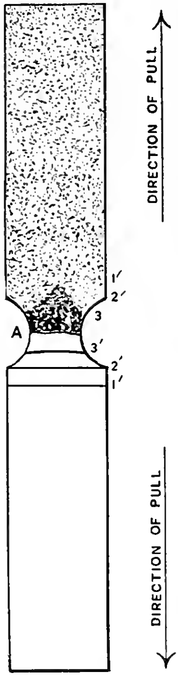


FIG. VIII.

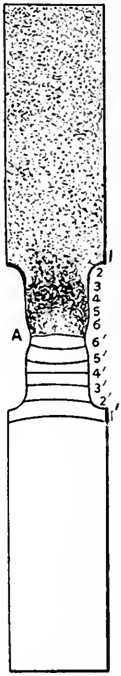


FIG. VII.

A indicates the point of fracture and contracted area. At 1, 2, and 3 we see how the metal began to flow in the middle of the test-piece, and was retarded by the shoulders. The lines 1^1 to 3^1 show this by their slight curvature at the middle, where the flow had been faster. From 4 to 8 flow was uniform, and the lines 4^1 to 8^1 are straight. At 9 flow begins to be more sluggish in the middle, and line 9^1 is curved in the opposite direction. Evidently the sides or edges flow faster toward the end of the test. As a result of this retardation the broken end of the piece is thinner in the middle than at the edges, as is shown in Fig. IX, which is taken from actual measurement. Analyzing the behavior of the metal, we see the retarding influence of shoulder and fillets. This is recognized by the allowance of clearance from datum point to bottom of fillet, of from $\frac{1}{10}$ to $\frac{1}{4}$ of an inch, so as to have the useful 8-inch section between 4 and 4^1. The portion of the test-piece from 4 to 9 is the really useful and valuable indicator of quality. In soft and moderately hard steels the way in which the portion 4 to 9 stretches after the elastic limit is reached is the criterion of the quality of the metal. At 9 a thickening or clogging of the particles seems to take place, and only some of the outer portions of the metal seem to be pulled down by force. The thickening, clogging, or hardening of the metal when it reaches 9, which corresponds with the maximum load the piece will carry, is sometimes forcibly illustrated by test-pieces with parallel sides, as in Fig. X.

From A to B the metal flows so much as to make the section perceptibly narrower. From B to C the flow has become obstructed by too great a density of the metal; the particles from A to B have flowed into it, and the remaining load, necessary to break the piece, is unable to set the metal, thus condensed or hardened, flowing again.

In Fig. VI, which was cut from the same plate, by the side of Fig. V, we see the retarding influence of fillet and shoulder, as well as of too narrow a section, very clearly. Between 1 and 3 there is hardly any flow. It begins at once at 3, and continues to 10, but evidently clogged, for the total elongation was 5 per cent. less than in Fig. V.

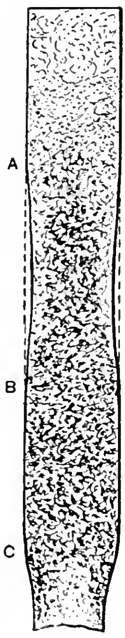


FIG. X.

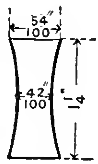


FIG. IX.

Only lines 1^1 and 11^1 are curved, showing same acceleration and retardation of the flow at the begnining and the end of the test. Fig. VII is the old and still much used 2-inch section, where the stretch at the point of rupture takes so much of the useful portion of the test-section as to naturally form the largest percentage of the resulting elongation.

Hence generally speaking, if the elongation in an 8-inch section is 25 per cent., it will be 35 or more per cent. in a 2-inch section.

In Fig. VIII we have the worst form of test-piece that ever existed; happily it is now but rarely used. As can be seen, no flow takes place in the body of the test-piece; it is confined exclusively to the small portion of metal at the point of fracture. Hence the engineer using such a section virtually says: "I do not mind at all what the behavior of my structure is below the point of actual fracture and break-down; all I care to know is at what load it may break."

We are thus forcibly reminded that, as we ascend from the groove or 1-inch section (Fig. VIII,) through any possible variation of forms, to the geometrically proportionate 8-inch section, we come nearer and nearer to the proper and scientifically correct measure of the quality of iron and steel for structural purposes.

Conversely, as we depart from the 8-inch section, our measure of quality becomes more and more unreliable, until finally it becomes a delusion and a snare in the 1-inch or groove section.

It is because of the better understanding of this that engineers more and more abandon the 2,-3,-and 4-inch sections, and adopt the 8-inch section.

This, of course, makes testing somewhat more expensive, because a 2-inch section requires less metal, less preparation, and less time. But what is this comparatively small expense against the increased safety and other advantages gained by a more reliable quality measure?

What are a thousand, or even ten thousand, dollars annually spent in the perfection of methods of testing and examining metal, when the known saving to large consumers, like railroad companies, ship-builders, etc., amounts to a hundred thousand dollars or more on account of prevention of accidents or, at least, reduction of wear and cost of repairs, and avoidance of delays, annoyances, vexations, not to say costly wrecks, due to increased ability to select the best grade of metal for a given purpose for the same price, because of better insight into the properties of metal and the selection of the right measure of quality.

Summing up, then, the results of our inquiry, we find:

(1) Structural iron and steel have all the characteristics of mineral substances of a viscid nature.

(2) The flow is more free and natural and less retarded in large than in small sections.

(3) Hence, in order that the metal in the test-section may exhibit the same degree of flow (which is the measure of quality of a given metal for a given purpose) that takes place in the complete structure, the test-piece should be as large as is practicable.

(4) That such test-piece, together with the best method of testing and inspection, should be adopted as a standard by engineers and consumers.

(5) Without such standard and uniform methods of testing and inspection, the results of the work of the individual engineer, and the merits and safety of the structure he has designed and built, cannot be

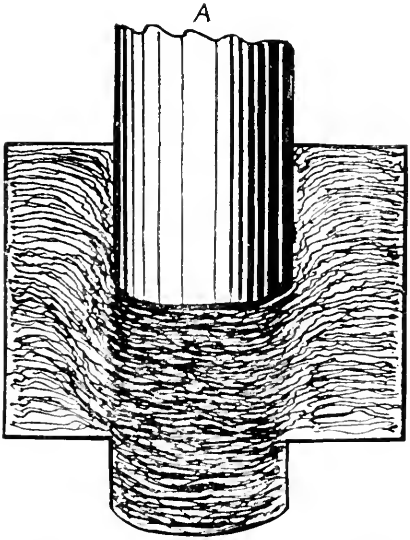


FIG. XI. FLOW OF METAL UNDER A PUNCH.

compared with those of other engineers, thus preventing interchange of ideas and experience, and hindering progress in engineering and in the manufacture of metals, besides increasing cost without benefit to the consumer.

(6) The properties of iron and steel are such that it is not necessary to prescribe an unvarying test-piece, and method of testing and inspection. But within certain narrow limits the same length, width, or diameter and shape should be used, as well as nearly uniform speed. In other words, there should be not only the largest amount of metal in the standard test-piece, but a practically uniform amount.

In conclusion, I would say that the attempt to graphically illustrate the flow of metal in a test-piece is not the result of imagination, or of a theory built upon elaborate deduction, but a record of observations of broken test-pieces that were highly polished. On slow pulling, the structure and arrangement of the particles during flow become plainly visible to the unaided eye. In fact, in some instances the shearlines and possible inequalities in the metal are so pronounced that a man can feel them. The concluding illustrations, taken, in three cases, directly from planed and etched metal sections, show how the plasticity of iron and steel helps, under favorable circumstances, to strengthen the members of a structure and, through this, the structure itself. In Fig. XI we have an exhibition of the well-known fact that the amount of metal punched out of a nut or plate is never as much as the amount of metal necessary to fill the hole punched, for the reason that, as the punch A advances, part of the metal escapes, or flows, from under the punch sideways into the body of the nut or plate, due to its plasticity. In Fig. XII we have a bolt which is materially strengthened by the fibers of the iron adapting themselves to the curvature of the outlines of the bolts. This tendency

FIG. XII. A BOLT HEAD.

to strengthening is still better seen in Fig. XIII, which shows how the metal of the rivet flows into every crevice and grips the two plates as if in a vise.

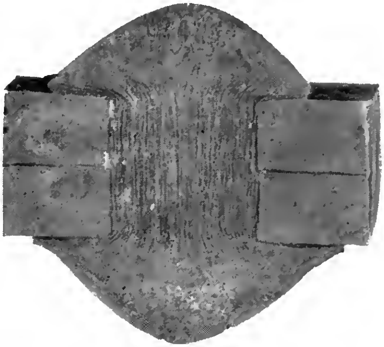


FIG. XIII. SECTION OF A RIVET.

Fig. XIV, is a U rail, such as were used in this country on our railroads some fifty years ago and later, as may possibly be remembered by some of the older readers of this magazine. We see again how the fibers of the iron adjusted themselves into the most favorable positions to add strength to the rail.

Thus, a study of the plasticity of iron and steel explains to the patient inquirer some of the perplexities which confront the engineer in his daily practice.

FIG. XIV. SECTION OF A U RAIL.

THE GOLD-FIELDS OF THE PORCE RIVER, COLOMBIA.

By J. D. Garrison.

THE writer of this paper was employed during the surveys for the so-called Intercontinental (Pan-American) Railway, through Central and South America, as principal assistant to the chief engineer of the surveys, and was assigned to duty with Corps No. 2, which operated between Quito in Ecuador and San José in Costa Rica. During the progress of the work on the line through the State of Antioquia, in the republic of Colombia, his attention was called, at various times, to the great mineral wealth of that State, and particularly to the gold mines of the Porce valley.

His opportunity for examining these mines at length, while engaged on the surveys, was necessarily limited, and consequently he was unable at the time to give the matter a full investigation. He saw enough, however, to convince him that some of the mines observed were of extraordinary richness, and, since the completion of the surveys, above referred to, he has made a careful examination of these and other mines in Colombia. He has just returned from Antioquia, where he has been examining a number of properties purchased by an American company in the valley of the Porce, and his investigations have disclosed results so startling that it has been thought advisable to make them public. The writer deems it proper to state, however, that, in making them public, he is not actuated by advertising motives, but merely by a desire to make known, especially in the States, what seems to him to be information of great value to the mining world.

The republic of Colombia has long been known to the Spaniards and their descendants as being exceedingly rich in its deposits of gold, but, owing to its geographical location and its climatic conditions, it was only during the past few years that it began to attract the attention of the world at large.

Recent investigation in the country, on the part of foreigners, has disclosed the fact that almost untold wealth lies hidden in its mountain chains and valley streams, and a movement has lately been begun that promises to result in inaugurating in the country a mining "boom" that will rival those that have been seen in Australia and the Transvaal.

The old Spaniard, who was a wonderful seeker after gold, knew the value of the Colombian mines, and he drew largely from them in gathering the wealth that went to enrich the "mother country" during the palmy days following the conquest of the southern hemisphere. His descendants, too, have profited by his knowledge, and have followed in his footsteps in taking from the bountiful stores that nature has lavishly placed at hand; and, in almost every section of the republic, they have continued to operate mines that, since the emancipation from Spain, have yielded, without machinery, a steady stream of the "yellow metal" which has swelled the output of the country to more than $700,000,000.

Nearly every State and province in Colombia has its gold deposits, more or less rich, and from some of these deposits have come, at times, yields that almost challenge belief. The stories that have come to the outside world, from time to time, of the gold alluvions of the Darien, Choco, Atrato, San Juan, Cauca, Nechi, and Porce, and the rumors set afloat regarding the fabulous richness of these fields and streams, have read for half a century like fairy tales. Yet many of these stories have a basis of truth. Explorations, in recent years, into the regions mentioned have brought to light the fact that, within their precincts, in some places, lie stores of wealth of vast extent, though formidably guarded against the encroachment of man by climatic and other conditions too deadly to face.

The State of Antioquia, though but little known, by reason of its almost inaccessible location, is perhaps the richest State, in mineral wealth, in all Colombia. Situated, it might be said, almost in the "lap of the Andes," and cross-seamed by many spurs from the parent chain, the State presents an almost unbroken area laced with gold-

BOLIVAR PARK, MEDELLIN, COLOMBIA.

GENERAL VIEW OF MEDELLIN, SITUATED ON THE UPPER PORCE.

bearing quartz veins of great value, while many of its streams have valley deposits of placer gold of almost incredible richness. Nearly $150,000,000 in gold have been taken out of the mines of this State during the present century, although most of the workings there have generally been limited to surface deposits easy to reach. A very large proportion of this amount has been taken from placer deposits in the valley of the Porce, a river that has long been known to be exceedingly rich in gold.

This river, which seems to be of comparatively recent origin, has its source in the heart of Antioquia, near the city of Medellin, and drains northwardly, between the two ranges of the Cordilleras, through a distance of about 175 miles, to its junction with the Nechi. Through a good portion of this length it is fed by mountain streams and torrents that have cut their way, in deep cañons, across the flanks of the Cordilleras, and that bring into the valley, with their detritus, gold from innumerable veins. As a consequence, the river has, for over sixty-five miles, an almost uninterrupted series of gravel bars, or flats, exceedingly rich in gold. So rich, indeed, are some of these bars that much speculation has been indulged in relative to the source of their supply.

The usually-accepted theory is that it comes from the mountain veins uncovered and cut by the torrents above referred to. An-

THE PORCE RIVER IN THE SUBURBS OF MEDELLIN.

other, and more prolific, source drawn upon appears to have been generally overlooked. From the topographical features of the country, and the geological formations exposed, it seems that, prior to the existence of the Porce, the drainage of this part of the continent was effected through an immense river, now extinct, which had its course almost parallel with the present direction of the Porce. This ancient river was evidently destroyed by volcanic action, and its bed, which was rich with the accumulated gold of ages, was thrown up and inclined against the mountain flanks. The Porce, afterwards breaking through the disturbed territory, and having feeders that cross and wash the inclined channel of the old river, has ever since been drawing from that immense source vast amounts of placer gold that, combined with the products of the quartz veins adjacent, have made up the richness of the valley bars.

Mining has been carried on in the valley to a greater or less extent for over three hundred years. The Indians inhabiting this portion of the continent washed out gold in a crude way, and they, of all the tribes in Colombia, had most gold to sell to the Spaniards. They frequently gave the "conquerors" twenty dollars in gold-dust for a pound of salt, and seventy dollars for a hatchet, and it is said that in one of their villages the Spaniards found more than $20,000 in gold. The Spaniards mined in the valley for many years with good results, and, following them, the natives also. From 1602 to 1620 more than $6,000,000 were washed out here, and, although working has been limited almost exclusively to superficial deposits, easy to mine, the output has steadily increased, until, in recent years, it has been estimated to run more than $1,000,000 annually.

Individual instances of great returns for working are on record. On the lower reach of the river the natives have taken out, by diving, pans of gravel that yielded more than two pounds of gold. One proprietor, after spending nearly $75,000 for the introduction of water, washed out, in a few days, more than 10,600 ounces of gold dust, and from a small bar in the river valley, though hardly 500 feet long by 50 feet wide, more than $200,000 were taken. At the Cristina mine, some years since, fourteen men, in thirty hours' work, washed out 118 ounces of gold, while at Barcinos 265 ounces were extracted from about 160 cubic yards of gravel. At Guayabalito the daily yield in the winter (dry) season, with a small force of men, runs from 44 to 102 ounces; at La Llave it has run from 26¼ to 29½ ounces; at Caracoli, from 58 to 73½; at Naranjal, 15; at Oralito, 73½; and, at Socorro Megaron, as much as 132. At San Basilio, in two weeks' work, 764 ounces of gold were taken out in the winter of 1886, and at San José 588 ounces were extracted in the working-season of 1885.

An English engineer of some repute examined and reported on

THE PORCE RIVER, NEAR MEDELLIN.

the richness of the Porce river some years since ; he estimated that the river contained gold in the proportion of $14\frac{7}{10}$ ounces per superficial square yard, and that in the lower fifty-mile reach of the river, after its junction with the Nechi, there were more than 4,000 tons of gold !

The writer of this paper noticed, during his connection with the surveys of the Intercontinental Railway, the richness of some of the Porce bars, and he has recently been conducting some examinations and tests which show results in keeping with those above described.

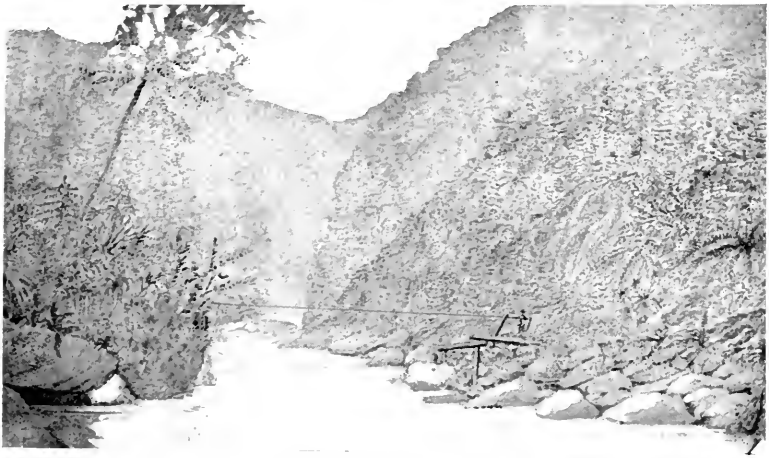
At one place, where the bar had a formation of about six feet of loose sand (decomposed granite) mixed with boulders, and below this another formation of gravel, sand, and boulders, the upper stratum showed, from the "grass roots" down, an average of $6 per

A PART OF THE PORCE WHERE BARS ARE FORMED.

cubic yard, while the lower stratum gave an average of more than $80 per cubic yard. At another place three cubic feet of gravel, taken as average from fifty different places in the lower stratum, yielded $15\frac{81}{100}$ grams of gold dust, or about $9 in gold ; there being $31\frac{1}{10}$ grams in 1 oz. Troy, which is valued, in this gold, at about $18.

At still another place, from 256 pounds of gravel, taken from sixteen different places, $6\frac{4}{10}$ castellanos of gold dust were washed out. This result corresponds to a yield of nearly $200 per cubic yard, the specific gravity of the gravel being about 2 and the weight of a cubic foot about 125 pounds. The former result corresponds to a yield of about $80 per cubic yard. Several wheelbarrows of gravel (three or four cubic yards), at another place, gave $435. One batea yielded $7.50 in gold dust, and, out of several hundred bateas taken, not one failed to show gold in immense paying quantities. Other tests were made with results equally startling, but those given serve to show the enormous richness of the river valley.

When one remembers that, according to Silliman, Cumenge, and Lock, the rich gravel along the Yuba river, and at "Pond's Claim," in California, averaged only from 34 to 45 cents per cubic yard, while the gravel at such mines as Independence, Todd's Valley, Roach Hill, and Iowa Hill ran only from 25 cents to 71 cents per cubic yard, he can begin in some measure to appreciate the enormity of these figures. The writer is constrained to admit that they read like a fairy tale, and, had not the richness of the river valley been fully demonstrated by the examinations of experts and by mining opera-

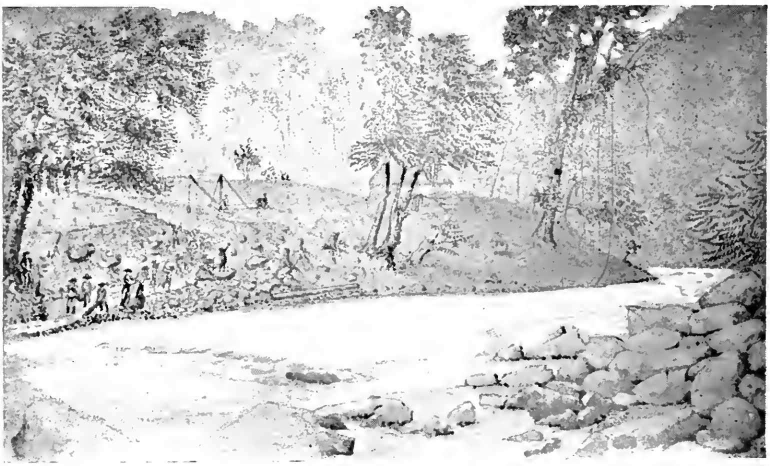


THE PORCE IN A REACH WHERE NO BARS HAVE FORMED.

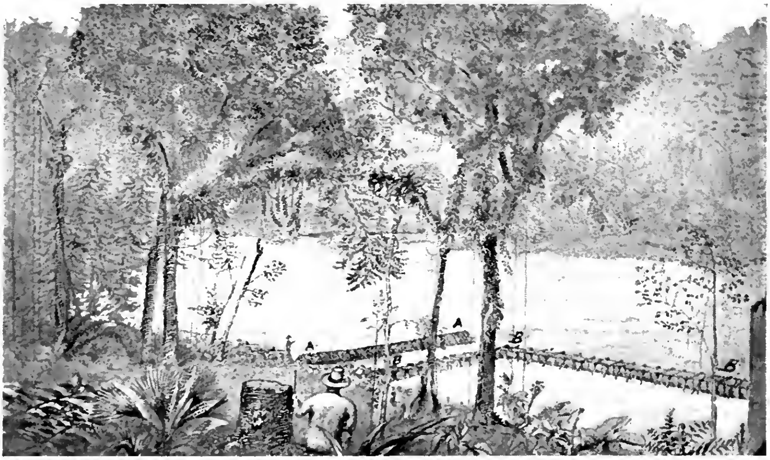
tions, he would certainly hesitate to give them. Of course, places have been found in California, and elsewhere, where the yield of gold was greater even than the figures given above. These places were known as "pockets," however, and were limited in extent, whereas almost the entire valley of the Porce seems to show the large average given; demonstrating the fact that, through exceptionally favorable conditions, the river has been, for many years, the reservoir for gold deposits from almost unlimited fields.

The question will naturally be asked: Why, if this river is so rich, has it not been mined out already? As before stated, mining operations have been carried on in the valley by the natives, and by the Indians before them, for more than three hundred years. They have been limited, however, almost exclusively to the deposits that were inclined against the hillsides, where bedrock was above the level of the river, and to the old channels that were easy to work. These deposits have been practically exhausted. The rich deposits, however, that lie below the level of the river, and that require expensive machinery to work them, are almost intact, and they have never been worked, except by the primitive method of "Veraneos," common in the country, which consists in sinking, in the dry season, to bed-rock, a rude caisson, composed of sticks, earth, and vines, and working the gravel thereby uncovered. No regularly organized scheme of mining these deposits has ever been carried out, and for obvious reasons.

Antioquia being situated far inland, and difficult of access by reason of the lofty Cordilleras on the east, south, and west, and the almost impenetrable jungles and morasses of the Atrato, Cauca, and Magdalena on the north, is almost unknown to foreigners, and even to the natives living on the coast. As a consequence, its mineral wealth has never been made known to the world, to attract miners, except through vague rumors that have come from an occasional wanderer who has found his way into the State by chance. And, when a foreigner, attracted by these rumors, has started to investigate them, he has usually become so appalled by the formidable obstacles presented by nature in his path, that he has generally turned aside to investigate fields in nearer provinces, report of which has reached his ear. The entire republic of Colombia is so rich in mineral wealth that the seeker after mines there generally becomes bewildered, as soon as he has entered the country, by reports coming to him, from almost every source, of mines fabulously rich that deserve his attention. As a re-



"VERANEO." CLEARING THE GROUND PREPARATORY TO BUILDING A CAISSON.



A CAISSON ABOUT COMPLETED.

sult, in face of the obstacles intervening between Antioquia and the coast, he generally turns aside to other and nearer fields. The writer knows personally of several expeditions that left the States for Antioquia, and were thus diverted. In view of these facts, very few foreigners have ever penetrated to the rich mines of the State, and those that have penetrated there have usually been unable to provide the capital necessary for working mines. The natives of Antioquia are not, as a rule, mining people, and those that have means sufficient to develop a mine are generally merchants who have made their money in trade, and who are unwilling to risk it in the more hazardous business of mining. There are only a few persons in all Antioquia having as much capital as $200,000 in gold, and they know absolutely nothing of forming large stock companies, such as we have in the States. Furthermore, those that have money live in the cities on the upper table-lands, where the climate is healthy, and they are unwilling, except when necessity compels, to venture into the lower and more unhealthy mining regions of the river valleys. In consequence of this, it is only those, generally, who have to become ruined or crippled in trade that undertake mining operations to recoup their fortunes; and it almost invariably happens, with these, that, as soon as they have amassed wealth enough to return to merchandising,—no matter how fabulously rich their mine or large its returns,—they either abandon the work to a foreman, or lease the mine to some one they wish to befriend.

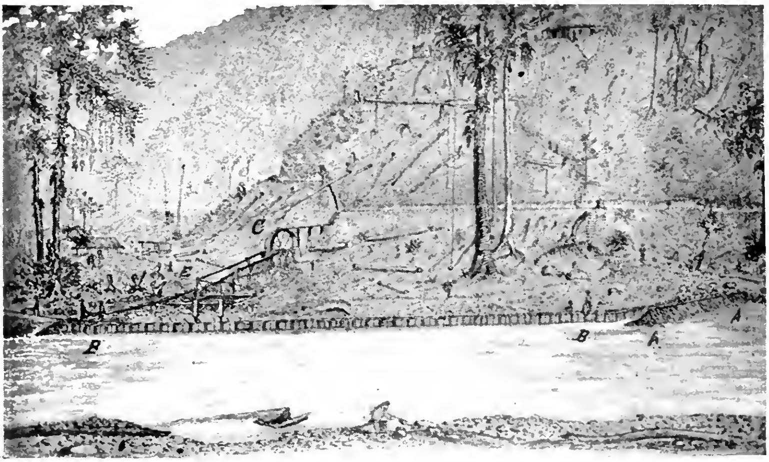
The climate, too, which is bad in the river valleys, and everywhere except on the elevated table-lands, and the highways, which are almost

WATER WHEEL AND PUMP AT ONE OF THE MINES.

impassable for machinery, have helped to throw obstacles in the way of mining on any extended scale.

All of these things have combined to prevent in Antioquia, and even in Colombia, a mining "boom" that would have led to the working of the alluvial deposits of the Porce. That such a "boom" will soon occur, however, is easy to be seen. The rich discoveries of silver which enriched Chili were made from 1825 to 1848; the gold alluvions of California were discovered in 1848; those of British Columbia in 1858; the rich silver mines in Nevada, which have lowered the price of silver, were discovered in 1859; those of Bolivia in 1860; the rich gold deposits of Guiana and Venezuela in 1866; and those of the Transvaal within recent years. Impelled by recent financial agitation in the States and elsewhere, the world is now "casting about," in every direction, for new gold fields, and Colombia's day appears, therefore, to be near at hand.

When that day shall have come, and, the present primitive appliances and methods being discarded, improved machinery and recently-discovered methods of mining shall have been applied to the working



PUMPING WATER FROM THE SPACE WITHIN THE CAISSON.

of the Porce and other Colombian streams, and to uncovering and extracting the gold from the vast lodes of quartz that are now lying hidden in Antioquia and other parts of Colombia, it is no hazardous venture to say that the world will view the results with unbounded amazement.

In order to prevent a misconception of the situation, it is eminently proper, before closing this paper, to warn persons against going to Colombia to mine without reasonable means. While the mining laws of the country are exceedingly liberal to both natives and foreigners, and while there are many rich mines to be discovered and claimed in nearly every section, it is still true that in Colombia, perhaps more than in any other country in the world, money is needed, especially for mining.

As for the valley of the Porce, there is probably, in all this territory, not a yard of soil that is not already taken, and nearly all of the river bars of any value are owned or controlled by a wealthy firm of native mine-owners, who do not care to sell them except for prices commensurate with their value.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

V.

By Henry Roland.

WHILE the contract system of labor-hiring may not now retain its place, in the estimation of authorities, as a thoroughly successful one, it nevertheless has played too large a part, and is still too widely used, to be omitted from the scheme of these articles.

It may well be that concerns operating under this plan are incurring a disadvantage in one direction which they can offset only by peculiar facilities in some other, as by the command of peculiarly favorable markets or unusually liberal profits. But the system marks a distinct step in the advance to a still better one.

It is yet in use in nearly all rolling-mills, and in many large and important machine-shops, but, though once believed the best possible for the production of good work at low cost-price, is now falling into disfavor, and by no means furnishes a guarantee against strikes and disagreements between employers and the employed.

I shall not treat the rolling-mill system with particularity. As is well known, this system embodies a "scale," or ton-prices for finished rolling-mill product agreed upon by the rolling-mill owners and the Amalgamated Societies of Steel and Iron-workers to hold for one year from date. After this price is once decided for the year, there is no trouble, but the agreement is often preceded by a time of stormy disagreement between mill-owners and mill-workers. In the usual form of "scale" working each boss roller hires, pays, and discharges his own gang of men, the head roller contracting directly with the owners, who pay into his hands the whole price of the work finished by him and his subordinates. As is the case with all contract systems, the pay of the contractor or head roller is very large in comparison with that of his assistants, and, in the light of the results of the contract system in other lines of metal-working industry, it seems probable that other methods can produce equally good results at less cost to the management and with less probability of trouble from conflicting interests. The use of the "scale" and the contract system is, however, at this time universal in rolling mills, and there is no present sign of immediate change in labor-employment methods in concerns of that class. It is probable, however, that the same general laws govern the contract system in rolling mills that have been found to dominate that system when used in machine shops and small-arms and sewing-machine factories, where the contract system was at one time regarded as possessing advantages not otherwise to be had, but where it has now fallen into disfavor, and either has been, or is likely soon to be, displaced by fixed-pay foremen in charge of piece-rate workmen.

Among the establishments still using the contract system are to be found many of the New England machine shops and armories,—the Pratt & Whitney Shops, employing about twelve hundred men, and Colt's Armory being among the more important examples. The Pratt & Whitney Shops, while still largely using the contract system, also work a great number of men at day wages, and the contract system is not regarded with favor by the management, although its use insures a constant reduction in cost-price of work, and special incidents frequently emphasize the advantages of the contract system in a manner to enforce attention. Thus, in case of an order for some half-dozen machines which could not be undertaken by the contractor who usually built them, as his department was full, the order was given to another department filled with workmen of a slightly higher grade than that of those employed by the contractor to whose department the job ordinarily would have gone, with the result of 70 per cent. increase in cost over the contractor's rate, while the work was not up to the contractor's standard. Here were better mechanics, taking them at a machine-shop estimate, and in a high-grade shop with the best facilities procurable, thoroughly experienced in the special line to which the lot of machines demanded belong; and yet these good men in this good shop produced inferior work at a very greatly increased cost-price. It was such instances as these which gave the contract system its prestige, and kept it in force for many years, in spite of the certain features inseparable from the system and extremely unpleasant to managers.

First of all, the contractor is and must be supreme in his department; he must fix the wages of his men, must have absolute control of them, must hire and discharge his help at will, and so becomes in effect an independent ruler in the territory of the management. If, as is the case in some shops, the management deals solely with the contractor, and delivers into his hands the savings of his department in a lump sum, the contractor paying his own men, then the management is wholly ignorant as to the compensation obtained by the contractor himself and of the cost of the work to the contractor, who keeps his own books, and is, in every sense of the word, an independent power, and a power which must obviously be treated as an equal, although actually occupying the anomalous position of a belligerent inferior. The interests of the contractor are directly opposed to those of the management, and the yearly "adjustment" of prices, always involving a reduction of the contractor's prices, is a constant source of perplexity and dissatisfaction to both parties. The management sees the contractor, in spite of the yearly cut in prices, constantly drawing larger pay than he could obtain as a foreman, because he seems always able to improve his methods so as to reduce the cost of his product to himself; hence the management believes that the contractor holds his improvements in reserve, and is, in effect, depriving the concern of the use of valuable methods of reducing cost known to himself alone, and kept back to neutralize the effect of future reductions in prices. The contractor is not unmindful of his own efforts in reducing the cost of work, which he rightly believes to have resulted greatly to the benefit of the management, and to justly entitle him to a portion of the increased profits arising from diminutions of cost effected by his skill and ingenuity. Hence the contractor, like the piece-work man whose piece-price is constantly reduced, finally ceases to exert himself, and makes his own gains so small as to ensure himself against reduction. It is very clear, therefore, that the contract system does not tend to develop ideal conditions of harmonious relation between the contractor and the management, and that, while strikes may be rare under a contract system, there is still a feeling of antagonism, growing out of opposing interests, which is unfavorable to the best results. The management does not wish the contractor to cease his efforts to reduce cost. It is, in fact, of vital interest to any and every machine-maker that quality be constantly improved, while cost is at the same time reduced. The shop which stands still goes backward, because of the advances made by rivals, and this condition of affairs points clearly to the substitution of the well-paid department foreman superintending piece-workers, in place of the contractor, paid at an unknown rate, with his force of day-workers. The contractor does not commonly pay his men piece-rates; in some cases contractors use sub-contractors, and in these this method was once largely in favor; at present, however, the contractor clearly recognizes the propriety of being himself the only high-pay man in his department, and makes his foreman and all other subordinates day-rate workers.

No more instructive example of the successive employment of day-rate, contract, and piece-rate workers can be found than that given by the labor management of the Singer Sewing Manufacturing Company, which has been in operation well towards fifty years, and has over 10,000 shop employees, all under the same management, precise information as to the policy of this establishment since 1863 being available. The Singer company had one strike in the New York shops at the time the eight-hour day was legalized; the strike was for an eight-hour day with ten hours' pay, and entailed a shut-down for five weeks, at the end of which the men came back to the regular ten-hour day, which has held ever since. The Singer company had in 1863 about 700 men at their only shop, located in Mott street, New York city, had no milling machines and no gang drillers, and was doing its work on lathes and planers. The parts did not "gage" at all; assembling was very expensive; and, after a machine was adjusted and in sewing order, all of the parts were kept by themselves while the frame was being japanned, and afterwards put back on the same frame, as they were very far from interchangeable. The pay at that time was principally by the day. In 1863 the Singer company put in its first ten milling machines, made by the Manhattan Fire Arms Co., at its Newark shops, on a modified Lincoln pattern. Following the success of these machines, many others were immediately introduced, gang drills and screw machines were brought in, and the whole place was brought up rapidly to the armory plant standard. With these improved tools, necessitating skilled or specialized laborers, instead of machinists, contracting came in, and day-pay went out. The contract system, with day-pay operatives under the contractors, became general in 1866–7, and held its own about fifteen years, until 1883, when it was finally dropped in favor of fixed day pay foremen and piece-rate workmen, which system is now in exclusive use at both the Elizabethport and the Glasgow factories.

At first each contractor hired, paid, and discharged his own men; with them the company had no dealings whatever, exercising over them only general authority in the matter of shop-regulations. These contractors were entirely in control of the work. They received with the contract small tools enough to equip the machine tools in their own departments, but the use of these small tools was optional with them; each contractor kept up his own tools, and, if he desired improvements in the tools, made them himself with his own tool-makers, of which each contractor kept a larger or smaller force at his own expense. It will be seen that, with this order of things, the management could be kept in almost total ignorance of the real course of affairs in any contractor's department, and, in point of fact, was kept in ignorance so far as the contractors could avoid giving information. Contractor's rates were made to hold from January 1 to December 31, and were reduced to what the management guessed was about the actual cost to the contractor. The result of all this was that, while some of the very small contractors made as little as $2,000 per year, some of the larger ones, running two hundred or more men each, made more than $10,000 a year, and these earnings (in all cases vastly more than they could have obtained elsewhere for their services) did not vary much from year to year in spite of the annual reduction in prices paid by the company. January 1 each contractor put his tool-makers at work and kept them busy until he saw the way clear to his usual earning for the twelve-month; then he confined his labors to thinking for the remainder of the unexpired contract time. This process was easier than at first sight it appears. With two hundred men a contractor had only to make each man turn out fifty dollars worth more work in the year than he produced the year before to make up his profit of $10,000, which the company found itself powerless to diminish. Say with two thousand workmen the contractors, great and small, might divide $100,000, or $125,000, among themselves, while at a day rate these same contractors could not have obtained more than $30,000 or $40,000, thus making the company pay a very large sum above what it believed the actual value of the contractor's services to be. This led very naturally to a close scrutiny of the situation, and resulted, first, in the payment of the contractor's men by the company directly. This looked like a very innocent and unimportant change, but it was really the thin end of the wedge which was ultimately to deprive the contractor of his profits. As soon as the company paid the workmen, it had correct information as to the piece-cost of the work, and could also, of course, discover which pieces were high and which low in price, in view of the labor-time consumed in production. Hence the company became able to approximate more closely to the contractor's possibilities of cost-reduction for the next year, and so could more intelligently "adjust" or reduce the prices offered in the annual contract. Yet this made little difference, on the whole, in the gains of the contractors. It was true that the price of work was annually reduced, and that the quality of the work steadily improved, but the company did not view the great gains of the contractors with any approach to satisfaction, and finally, about 1883, the whole contract system was abrogated, and the policy of fixed-pay foremen and piece-rate workers was substituted without the slightest difficulty, the old contractors, without exception, remaining as foremen, though under greatly reduced pay, even very generous foreman's wages being far below the great sums obtained yearly by the same men in their previous positions.

Some of the worst features of contracting, especially the sub-contractor extortion, had been previously eliminated. By the sub-contractor system the principal contractor became almost an idler, drawing a large sum of money for merely nominal service. The sub-contractors drew large pay and were directly interested in continuing the system, which virtually made the company pay two large profits to its own workmen for its own work done in its own shop on its own tools, all paid with its own money. But the sub-contractor system was not very long endured after its full scope and purport became apparent. It is not obvious at first sight that the company could be a loser by the sub-contract system. It seems that, having agreed upon a certain price for a certain number of certain pieces of work, it had put the matter in final form, and that the sub-contractor was a matter of interest to the principal contractor only. But the sub-contractor extended the principle of efficiency brought into play by the contract system itself, which is the certainty that constant, minute, and highly-interested scouting directed upon any article of manufacture by specially-trained intelligence will always result in a reduction of cost. Hence the more contractors, the more minute the sub-divisions of the narrow field of observation, and the more improvements devised and retained until after the signing of the yearly contract for development, to bring the new year's profits under the reduced scale up to the previous year's standard. It is clearly seen in this light how the specious claims of the contract system to economy could remain so long unconfuted. The advocate of the contract system truthfully asserted that the constant close attention of the contractor made work cheaper than it would be made under the mere general observation of any superintendent, no matter how able, and that, since the high pay of the contractor was coupled with a low piece-rate to the company, the contractor's large profit was simply good money well paid to a good and profitable servant.

The true answer to the foregoing is fully given by the experience of the Singer Company, which is especially valuable because it has embraced a large number of operatives, and has extended over a long period, and hence is removed from the possibilities of special premises or developments which might cause results from smaller or less extended application of its methods to be regarded as but doubtfully conclusive.

This experience shows that, with fixed-pay foremen, the cost-reduction is fully as constant and rapid as it was under the contract system, and this saving comes sooner to the owners. Suppose a contractor, having already in view sufficient improvements to make his profit for a certain year, should in January devise a further improvement; he would then hold that until after the next contract was made, and it would be almost two years from the time the contractor knew of the possible gain before the owners begin to benefit by it. As things now are, as soon as an employee devises an improvement in manufacture, he brings it to the management and it can be used at once, instead of the owners having to wait for the knowledge of it until it becomes needful to the foreman's interest to use it. Experience has shown that, with a wise and liberal policy pervading the establishment, and with a good system of accounts, the heads of departments will have sufficieht ambition to make a good showing, and so friendly a rivalry will exist between departments worked on the piece-work system as to effect a satisfactory economy, while preserving a better feeling among the employees than is secured by any other method.

The pay of the operatives under the piece-rate is better than it it was under the day-rate, and is not reduced by a reduction in rates resulting from improvement in methods or tools.

Whether the same causes which make the contract system unsatisfactory to the machine shops will finally result in banishing the "scale" and the "boss roller" system from the rolling mills or no cannot now be predicted. The laws of contract labor cannot vary in their results; yet it may be a long time before fixed-pay bosses and piece-paid workers come into the rolling-mills, and it may even be a long time before all the contractors disappear from the New England shops.

There are abundant anomalous conditions in actual labor employment in the United States, and the discrepancies may continue for a long time, although one of them, the high machine labor prices in the vicinity of Cleveland, Ohio, seems in a way to regulate itself, as it is reported that the Brush Electric will remove from Cleveland to Lynn, Mass., and that the Lozier cycle factory will go from Toledo to some point east of New York, to escape the exactions of thoroughly-organized labor, which make machine production more expensive in that region than elsewhere.

One thing seems certain, however,—the gradual extinction of the contract system and its replacement by fixed-pay foremen controlling piece-rate workmen.

MATERIALS AND METHODS IN FIRE-PROOF CONSTRUCTION.

By Wm. M. Scanlan.

THE educated architect of to-day is familiar with the strengths and characteristics of building materials as established by scientific investigation, and knows how to use these materials most economically. The improvements in modern building, together with the large reduction in cost per cubic foot of space, testify to the beneficial results of this knowledge. The fire loss, however, is still an enormous tax upon the wealth of the country, and the methods adopted to render buildings safe from destruction by fire are often unreliable, expensive, and troublesome. This state of affairs indicates that the problem of fire-proof construction has not been taken up for scientific consideration, and that architects have not the same facilities for acquiring information on this subject that they have as to other branches of the building trades. There is, however, a growing interest in the subject of fire-proofing, and a very general desire for a larger knowledge of fire-proofing materials and methods. It is significant that in a description of the great Manhattan Life Insurance Building in New York city, written by one of its architects, Mr. Francis H. Kimball, and published in THE ENGINEERING MAGAZINE, the only details which Mr. Kimball criticises, and in which he suggests improvements, are the fire-proof floors and partitions.

An architect, in designing a fire-proof building, usually proceeds to design the steel framing for the floors without waiting to decide what kind of fire-proof filling he will place between the beams. If, as is usually the case, his ceilings must be flat, he concludes that some kind of hollow flat arch will be used, and fixes the span of the arch at about five feet. Now, this arrangement is precisely that which was introduced in 1871 by Mr. George H. Johnson, the pioneer in the use of hollow tile in floor-construction, and, while the rolling mills have progressed with the times, substituting steel for iron and improving the shapes of sections, constantly reducing the cost of their part of the floor, most manufacturers of fire-proof arches have remained stationary for the last twenty-five years, and the generally-used form of hollow-tile flooring has shown no improvement in design or construction since its introduction.

The ideal arrangement of steel framework for ordinary office-buildings is one consisting entirely of columns and girders. The girders should be placed in line with the partitions, so that the ample non-conducting fire-proof covering with which the girders should be protected would appear in the room as a cornice. On these girders the fire-proof floor should rest, and it is entirely possible to construct self-supporting, non-thrusting fire-proof floors covering the area of an ordinary office that will render loose tiles and cracked ceilings impossible. It is generally admitted that, the less steel there is in the construction of an incombustible building, the more nearly fire-proof it is, and many instances are pointed out where the iron or steel in the floors or roofs hastened the destruction of the building by expanding and throwing out the walls, or by softening and sagging sufficiently to allow the floor arches to fall. In tall commercial buildings economy of space requires thin partitions and small columns ; now, steel occupies less space than any other material that will carry the loads, and, when protected against fire, will cease to be an element of danger.

The simplest and most obvious way to protect steel from the action of heat is to surround it with a covering of some non-conducting substance, which will remain in place despite the action of fire and water, and which will not act injuriously on the steel where it comes in contact with it. A simple experiment on the kitchen stove will show which of the various substances now offered in the market as fire-proof building materials is the best non-conductor, and therefore the best material to use for preventing the heat of a fire from reaching a steel column or girder. Take flat pieces of dense tile, porous tile, cement concrete, and plaster of Paris, of the same thickness, and lay them side by side on top of a hot stove. Place on the center of each a piece of lead, and see which piece of metal remains unmelted the longest. It will be found that the lead on the dense tile will melt first, that on the portland cement next, and that on the plaster of Paris and porous tiling last. Plaster of Paris retains its moisture for so long a time after setting that it should be thoroughly dried at a moderate heat before the experiment ; otherwise, it will remain at a temperature of 212° until all the water in it is evaporated.

To see how the different materials will stand the application of cold water while they are in a heated state, the different samples may be dropped into a pail of cold water as soon as removed from the stove ; it will then be found that the plaster of Paris suffers more than the others, as fine cracks or checks will appear on its surface and it will lose nearly all its tensile strength. As a result of such experiments, it was found that porous tiling was the best material to use for protecting the columns and girders of a building from the action of fire ; it is as good a non-conductor as any for the purpose, and is not injuriously affected by cold water applied while the tiling is hot.

It is clear from the foregoing that the heat of a fire in a building can be kept from the structural steel by surrounding the columns, girders, and beams with porous tiling; the thickness required depends entirely upon the intensity of the heat and the duration of the fire. As much protection can be given as the owner is willing to pay for, in money and space. The question of thickness of covering is a point commonly overlooked, and we find buildings containing great masses of combustible merchandise constructed with no more precautions against fire than are commonly taken in an office-building with very little combustible contents.

Connected with the question of floor framing and columns is the question of weight of floor, and this leads us to the consideration of the prevalent custom of piling up dead weight on top of the arches, in the form of concrete filling. There is no reason why the tile arches should not extend to the top of the steel beams. This may increase the cost of the tile, but it will save not only the cost of the concrete, but also the time required for putting it in place and drying it out, besides keeping out of the building a vast amount of water that has all to be evaporated before the building is dry. Again, the deeper arch will be lighter, stronger, and stiffer than the shallow arch and concrete.

In some cases, and especially in New York city, it has been customary to use tile arches merely as a fire stop between stories, the floor boards being carried on wooden joists reaching from beam to beam and a hollow space being left between the top of the arch and the bottom of the joists. This method saves the use of concrete, but it does not deserve the name of fire-proofing, as the floor is carried on wooden joists and a hollow space is left by which the fire can communicate from one joist to another, besides which the wooden joists and flooring are placed directly upon the unprotected upper half of the steel floor beams. A construction similar to this was practically tested, with disastrous results, in the Manhattan Bank Building fire in New York.

An architect, having designed the floor-framing plan of the building, is ready to consider bids for the fire-proofing, and here he is confronted by a large number of different varieties of fire-proofing and forms of construction, each claimed by its manufacturers to be the best. Each system of fire-proofing worthy the name uses either dense tile, porous tile, cement concrete, or plaster of Paris as its principal material. If it were necessary, we could experiment to determine which forms the best flooring for resisting the action of fire and water, and for carrying loads. With regard to two of the materials we are certainly saved this trouble. The exhaustive tests of floor arches made at Denver, Colo., under the supervision of Messrs. Andrews, Jaques & Rantoul, architects, of Boston, which the writer personally witnessed, have settled the question beyond a doubt as between dense tile and porous tile—or porous terra cotta, as it is sometimes called.

It does not speak well for the progressiveness of our architects that these tests, which were exceedingly thorough and exhaustive, and the results of which, though published in a widely-circulated architectural journal*, have never been questioned, should have had so little effect on the construction of later fire-proof buildings. The material and form of construction that were proven vastly inferior are still largely used by some of our leading architects. The manufacturers of fire-proof tiling are more to blame for this than the architects, as, instead of producing the better material only, they continue to turn out the inferior dense tile. Properly made and burned, there is no safer or more substantial material entering into the construction of a building than porous tiling, and, from the manufacturers' standpoint, porous tiling, when its manufacture is understood, is more easily, more cheaply, and more rapidly produced than dense tiling. Mental inertia, however, tends to keep manufacturers from adopting new materials and methods as long as there is a market for old wares.

Briefly stated, the tests of fire-proof materials at Denver proved that dense tile is unfit for the purpose of fire-proof construction, because it is too brittle, breaking at the first blow like a sheet of glass, and because it does not stand the action of fire, or of fire and water, in each case acting very much like glass. The tests further showed that the dense tile "side method" arch was greatly inferior in weight-bearing capacity to the porous terra cotta "end construction" arch. The condemnation of the dense tile arches by these tests is rendered more emphatic by the fact that two separate sets of arches of this kind were tested, each set made and erected by a different manufacturer, the results in the two cases being almost identical. These tests showed, on the other hand, that porous tile end construction arches could hardly be improved upon in strength to carry a dead load, or in ability to withstand shocks or blows, or in resistance to the action of fire, or of fire and water. After twenty-four hours of continuous fire under one arch, and of fire alternating with a stream of water under another, the porous tile arches carried as much weight and stood as many blows as did the two arches which had not been subjected to the fire tests.

That the results of these Denver tests are borne out in practice is testified to by Mr. Chas. H. Bebb, who, in a description of the fire in the Chicago Athletic Club, in THE ENGINEERING MAGAZINE, says: "While the results obtained (in the Denver tests) may have been considered problematical, this recent fire has been a practical test of their

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* *American Architect*, March 28, 1891.

accuracy beyond question..... In its structural entirety the Athletic Club Building remained intact. The tile arches of porous terra cotta, set according to the very latest adoption in construction,—*viz.*, end construction,—are practically uninjured by the combined action of intense heat and tons of cold water; not an arch has fallen, and recent tests made on the worst-looking arches developed a sustaining capacity of four hundred and fifty pounds per square foot, without sign of rupture."

Dense fire-clay tile was the pioneer in the field, and served a good purpose in supplanting the heavy brick arch, but it has done its work, and must give place to a better material.

Let us next consider cement concrete as a structural material for fire-proofing purposes. When once in place, of good composition, well manipulated, and thoroughly dried out, it answers the purpose of a fire-proof floor well, and, under these circumstances, there is but one objection to it—its excessive weight. The practical objections to it, developed as the work of building progresses, are the watchfulness and care required to insure that proper materials in the proper proportions are used in its composition, and that the mixing and ramming into place are properly done. Another objection to it is the large amount of water used in its mixing, which should all be dried out before the wood finish is brought into the building; this involves delay, and in large buildings the loss of revenue caused by even a few days' delay is a large item. Some idea of the annoyance caused by the presence of moisture in a large building may be gained by reading Mr. Kimball's article. Cement concrete is manufactured at the building day by day, while the clay blocks are brought to the building ready made, so that proper inspection and rejection of poor material and work are more difficult in the case of concrete than in the case of porous tile. It is much easier to insure the use of good mortar and good joints between the clay blocks than to secure uniformly good work in the great mass of concrete to be used. Concrete is heavier, no stronger, no cheaper, less reliable, and has no better fire-resisting qualities than porous tile, and porous tile is a better non-conductor of heat.

The advantage that concrete has enjoyed over hollow-tile for flooring was that it could be used with iron tension rods and carried to greater spans, without thrust, than is possible with the ordinary flat arch. But, since the introduction of steel tension-rods in combination with porous tile blocks, the concrete has not even this advantage, and there are several reasons, stated above, for choosing porous tile in preference to concrete.

There remains now only one material to be considered—plaster of Paris and other forms of gypsum. This is usually mixed with shavings, chips, etc., and used in connection with suspension cables stretching from beam to beam. All the objections (excepting that as to weight) applying to cement concrete apply with equal force to plaster of Paris. As this substance sets so very quickly, it requires skill and quickness to get it into position before it sets. In setting it hardens at the surface before it does at the inside, and this sometimes causes the surface of the ceiling to tear away from the mass. But probably the most annoying feature of the use of gypsum is the extremely long time during which it retains moisture. In the process of mixing with wood shavings, these shavings become saturated with water, and, when the mass is put in place, the gypsum sets at the surface first, rendering it difficult for the water to escape from the interior. Of course this moisture does escape after a while, and naturally, by descending through the ceiling, to the destruction of the tinting or the decorations that may have been placed thereon. Again, gypsum has a destructive corroding effect on iron and steel in contact with it; the suspension cables and rods connected with it are usually galvanized, but the steel beams are protected merely by the usual coat of paint. Again, the shavings and chips buried in the plaster of Paris are certain to be disintegrated by the action of dry rot, and in the course of time, when the shavings and chips have rotted, nothing will remain but a honeycombed mass of plaster of Paris, through which the suspension cables can readily cut. Like cement concrete, plaster of Paris has no advantage over porous tiling as a fire-proof material, except its light weight, and it is inferior in important particulars.

Of the four materials there seems, therefore, to be no reason why porous tiling should not be chosen as the best—in fact, the only unobjectionable fire-proof building material.

Porous tiling is made from plastic clays by mixing with the clay from fifty to sixty per cent. of sawdust, by bulk, and then, after thoroughly drying the material, burning it in a down-draft kiln. When the heat in the kiln becomes great enough, the sawdust in the mass of clay ignites and is consumed, thus helping to burn the clay all through evenly, and also leaving little cavities or cells in it. This cellular clay is known as porous tiling. It is much lighter than dense tile, but it has a toughness and resilience that render it much more reliable.

A point that is not generally considered is that, for the purpose of a floor arch in the form of hollow tiles, an excessive crushing strength in the material is a disadvantage, for the reason that, the denser and harder the material, the more brittle it is. We need crushing strength to withstand, with a reasonable factor of safety, the strain developed by the load carried, but, beyond this, increased crushing strength is uselessly attained at the expense of the very essential quality of toughness.

There are two general methods of arrangement of arch blocks in fire-proof floors, known respectively as the side method and the end method. The latter was first used for floor construction by Thomas A. Lee, in 1886. While other manufacturers have varied the shapes of the end construction blocks, the original square block of porous tile remains the simplest and easiest form to manufacture and to build, and gives the best results. (See Figs. 1 and 2.) The side method is the older, and is used generally by the manufacturers of dense tile arches ; with dense tile it should speedily pass out of use, as poorly adapted to its purpose. (See Fig. 3.) In the side method arch the hollows in the tile run parallel with the supporting beams, and the disposition of the material in the arch is not at all in accordance with proper methods of design, inasmuch as the line of pressure of the arch has no solid material through which to act, and the abutment blocks are poorly adapted to withstand a shearing strain. Hence arches built after the side method, when weighted to destruction, invariably fail at the abutments under a load that does not develop a compressive strain of more than a small fraction of the compressive strength of the material.

In the end construction arch the disposition of the material is such that there is little or no waste material. All the vertical ribs are continuous, and extend from beam to beam, so that the curve of pressure of the arch acts through solid material throughout its whole length. The top and middle webs aid in taking the end pressure at the middle of the span, and the only part of the arch that is not in compression—*viz.*, the bottom of the shell—furnishes the level surface for the ceiling plastering. This construction is analogous to a series of incombustible joists extending from beam to beam, and having fastened to them incombustible boards, at top and bottom.

Whether the arch be built on the side method or the end method, the objectionable feature of end thrust is still there, ever tending to spread further apart the supporting beams, necessitating thorough tieing together of the beams, and causing most of the cracks that appear in the ceilings of the fire-proof buildings. I-beams are not designed to stand a lateral strain, and the thrust of the arches must be neutralized by efficient tie-rods close to the bottoms of the beams.

It is clear that, if sufficient tensile strength should be supplied near the bottom of an end construction arch, the structure would become a beam, and would act as a beam under all conditions. The top would be in compression, and the bottom in tension, when the structure was supported at the ends, and there would be no more thrust to be considered than in the case of a wooden joist. The desirability of extending the end construction arch to spans of any length, and the necessity of making the structure a beam rather than an arch, in order to abolish the thrust, has led to the invention known as the porous tile beam-floor. This is an extension of the end method arch idea, and, to supply the needed tensile strength, there are supplied near the bottoms of the tiles steel tension-rods, composed of two strands, embedded in strong portland cement in the joints between the courses of tiles.

When the beam-floor is supported at the ends of the spans, the tendency to deflect produces compression at the top, and tension at the bottom, of the beam. The material in the porous tile is well adapted to stand a compressive strain, its ultimate crushing strength being 1,200 to 1,400 pounds per square inch ; and it is necessary to supply only enough steel in the tension-rod at the bottom of the tile, in order to furnish tensile strength to balance the compressive strength at the upper part of the blocks. As cold-drawn steel wire has a tensile strength of 110,000 to 180,000 pounds per square inch, very little steel is required. No extension of the bottom of the structure under the action of a load is possible without stretching the steel tension-rods. As the thickness of tiling under the rods may be made as great as necessary, the structure can be made absolutely fire-proof.

The beam-floor, whether of porous tile or concrete, is unquestionably better than any form of arch construction. With the arch, it is impracticable to use long spans and retain level ceilings, and, where, as is usually the case, floor beams are provided, spaced from four to six feet apart, all of these beams may be saved by using a fire-proof beam-floor, extending from bearing to bearing; the substitution will give a stronger, stiffer, and lighter fire-proof floor at a decreased cost. As to the choice between concrete and porous tile beam-floors, the advantages and disadvantages of the two materials have already been discussed in this article. The porous tile beam-floor, by the thorough tieing together of all tiles in the floor, overcomes some very serious defects in the arch floor. It overcomes the cracking of the ceilings due to the deflection of isolated I-beams carrying arches; it removes the danger of whole arches falling out of the I-beams, when, from any cause, the beams have spread, or (most probably the initial cause of the Ireland Building disaster) when the rain has softened or washed out the fresh mortar of the joints of the arches.

The writer feels that there is much room for development in the field of fire-proof construction, and he has been intentionally explicit in naming those forms of construction that seem to him the best, in the hope that, if he is wrong, his errors may be pointed out. That the subject is worthy of the attention of all is evident when we consider that the past and present methods of building are costing the United States an annual fire tax of one hundred and fifty millions of dollars, as well as the loss of many lives.

REVIEW OF THE ENGINEERING PRESS

The Nicaragua Canal Company's Methods.

THE RAILROAD GAZETTE (Jan. 29) makes a severe criticism on the present methods and attitude of the Nicaragua Canal Company. The company has really no longer any standing in Nicaragua, and now would be glad "to unload a forfeited concession upon the United States government, and leave that government under the necessity of using the 'resources of civilization' against little Nicaragua, or lose its investment." Our contemporary says: "The obstinate opposition made by the officers of the Nicaragua Canal Company to every proposition to have more complete surveys and studies made before the nation should become responsible for the money to carry on the work has long been something of a mystery. It is hard to see why a course should be taken which was obviously delaying the settlement of the question, if the canal company really felt as secure in its position as it pretended to feel. The most extraordinary reason for haste which has been brought forward is that given by Mr. Miller, who urged that a waiting world should be relieved from doubt, and that capitalists at home and abroad feared to put their money into the project, lest the United States government should guarantee the bonds, and thus relieve the investor, not only of risk, but of the chance for a speculative profit. We suppose that even school-boys saw through the flimsiness of this argument." Evidence that the concession has been forfeited is referred to in a recently-printed letter addressed January 15, to the secretary of State by Senor Rodriguez, the minister of the Greater Republic of Central America. He declares that the five bills before congress relating to this canal "all take it for granted that the government of the United States is to take an important part in the enterprise and to furnish the money for construction," and that "the provisions of each are at variance with the stipulations of the contract of April 24, 1887, between Nicaragua and the company, from which contract the company derives its existence." It is expressly stipulated in this contract that the concession shall not be transferred to any foreign government, under penalty of the forfeiture of the concession. Moreover, the time allowed in the concession for the completion of the canal has long ago expired, and this fact alone is a sufficient forfeiture of the original concession. Great efforts have been put forth to raise money for the scheme; all the same, the money has not materialized. The renunciation of the concession is, therefore, demanded. Perhaps, as a matter of statecraft, such a demand is right and proper; but to simple laymen it appears not at all essential that a man or company that has violated a contract should formally declare his renunciation of it, or that any government or governments should declare it, or declare anything at all except the fact that, by reason of the non-fulfillment of the agreement, all the rights and privileges specified in the agreement have lapsed and become of no effect. In ordinary business the method slangily but forcibly characterized as "firing out" would be the summary, and most probable, way of treating a delinquent of this sort. Our contemporary states what we believe all fair, broad-minded men will concede,—that England has no idea of obtaining control of this waterway, and that she, in common with the other great European powers, perceives that a "guarantee of neutrality by all the great powers is the only living status for such a waterway." This is the attitude of the powers toward, and the present status of, the Suez canal. If this be a just view of England's position, the outcry that has recently been made about her desire to gain possession and control of the Nicaragua waterway will be taken by most people at what it is worth for its possible service in helping the company out of its present plight.

Working Thin Coal Seams by Electrical Mining Machines.

Mr. Jabez Hanford, in *American Manufacturer* (Jan. 8), expresses the suspicion (to put it mildly) "that some of our mining plants have not mined the thin seams of coal as economically as was previously done by hand." He also raises the question of the comparative economy of electricity and compressed air as motive power for mining machinery in general, but does not broadly discuss it. In considering this part of the subject, he refers to results attained by a plant constructed by the Ingersoll-Sergeant Drill Co., and makes a special comparison of cost per ton for coal-getting with this plant and the cost per ton of pick-mining previous to the installation of the Ingersoll-Sergeant plant, which consists of two 80-h. p. boilers, 60″ in diameter and 16′ long, one piston-inlet air-compressor, with a steam cylinder 20″ × 24″ and an air-cylinder 20¼″ × 24″, and ten mining machines of the intermittent cutting type. Upon the working of this plant Mr. Hanford makes a report, an abstract of which here follows: "Our seam of coal is known in the second geological survey of the State of Pennsylvania as the 'Darlington coal.' It is three feet thick and slightly undulating in character, with a band of slate one inch thick about three or four inches from the bottom. The roof is very strong slate, except where the workings are driven near the crop of coal, and the bottom is of soft fire-clay. The price paid for mining by hand is 70 cents per ton, screened coal. For driving entry, from $2.25 to $3 per yard; for airing, from 75 cents to $1 per yard. Price paid for cutting in rooms on this basis is 16 cents per ton, and 35 cents per ton for loading; for cutting entry and airways, 50 cents per yard, and 45 cents per ton for loading. The slate for height in the entries is afterwards taken down by the company. Mr. Hanford then makes an estimate of the cost of coal-getting by the compressed-air plant, including favorable and unfavorable times of year, finding that machine-mining in this mine effects a saving of $19\frac{7}{10}$ per cent. on room coal alone, 18 per cent. on entries, 38 per cent. on airways, and $12\frac{8}{10}$ per cent. on the total output. He further finds that, in the mine he is considering, compressed air is more economical and convenient than electricity for pumping; that the compressed-air machines are lighter, and, therefore, more easily moved about from place to place, than the electric machines; that in certain situations the air-driven machines may be used where the electric machines require so much space that their use becomes impracticable; and that in other respects the compressed-air machines are more convenient and safer to the men working in the mines than the electric wires. Mr. Hanford disclaims any intention of extending this comparison to other mines as a general conclusion in favor of compressed air as contrasted with electricity for mining purposes. He speaks only for the mine in question, attributing the good results very much to the particular adaptation of the plant to the existing conditions. The plant should harmonize with the conditions. "It is useless to try to harmonize conditions with a plant."

The Conducting Capacity of the Cast Weld Joint.

The necessity of copper bonds in cast weld joints seems to be very clearly indicated by the results of tests made by Mr. Harold P. Brown, as recorded in an article from his pen in the *Street Railway Review* (Dec. 15). According to Mr. Brown, one of these joints was brought to the Edison laboratory some two years ago to be tested for its conductivity, the makers claiming that the joint was a better conductor than the rail itself, and that, therefore, a bond was unnecessary. Examination showed that mechanically the joint was all that could be desired, and a careful test showed the conductivity to be equal to a very good bond of No. 0000 copper. It was seen, however, that the cast iron was not actually welded to the steel; so, after burial in the earth for about two months, the tests for conductivity were repeated. The resistance of the joint had doubled in the interim. This is accounted for by the penetration of water between the cast-iron and steel surfaces, not in perfect contact, and the consequent formation of a film of iron oxid. The mechanical performance of the cast-weld joints has proved excellent everywhere, but, even where bonded with copper, their resistance—at least after some time of use—is very much too high for economy. In Newark, Mr. Brown says, the average of several hundred measurements, excluding broken joints, showed the resistance of a foot of rail in each joint to be five times as much as that of a foot of rail between the joints, notwithstanding the joints were also bonded with copper, the copper bonds having been left in place at the time the cast-weld joints were made on several miles of 60-pound girder rails. Mr. Brown was so much interested in the matter that, after having his Weston instruments calibrated, he took them with him to St. Louis to see what he could there learn further respecting these joints. With reference to this part of his investigation, he says that a new cast weld joint was found to have a conductivity equal to about two No. 0000 copper bonds; that a year's use reduced this to about one-tenth of the initial conductivity; and that a little plug of Mr. Edison's plastic material reduced the loss to one-sixth at the start, and to one-fiftieth after a year's use. While in other cities the joint has proved very successful mechanically, it has been found "necessary to use a liberal amount of copper bonding in order to operate the road." In many instances the want of actual union between the cast-iron and the steel of the rail was very easily discernible.

Efficiency of Worm Gearing.

WHEN a very great reduction of speed is required, as is now often the case in the application of electric motors to machine driving, the very simplest means of effecting the desired result is the device known as worm gearing. This fact has of late brought it into prominence as one of the useful mechanical movements, and it has been substituted with much success for spur and level gearing that would otherwise have been required. All the same, worm gearing is still regarded with prejudice by many mechanics,—a prejudice which we confess to having shared. Only a set of favoring conditions, which, in many cases, can fortunately be secured, but which are impracticable in other cases, could induce us to adopt this method of reducing speed. One serious objection to reducing speed by the use of spur, bevel, and miter gearing has been the noisy character of their action; another is its cost as compared with that of worm gear. The objectionable noise, however, has been so mitigated by the use of rawhide gearing that, practically, it need no longer be much considered. Not so the cost, which will, under nearly all circumstances, exceed that of worm gearing. The conditions under which the latter may prove serviceable and economical cannot always be established and maintained. A good article on this subject (*American Machinist*, Jan. 21) states these conditions concisely. "The general line of change which has secured improved results has been in the use of steeper pitches than formerly, in the use of an oil cellar by which flooded lubrication is secured, and by the adoption of the Hindley form of worm. We should add to this the boxing-in of the gearing to exclude dirt in cases where much gritty dust is likely to foul the working surfaces. As we have said, all this is sometimes impracticable, and in any such case we should prefer a system of spur, bevel, or miter gearing, or, perhaps, a system comprising the three kinds. With such gearing we have lately reduced a very high speed to a very low one in a most satisfactory manner under conditions which, in our judgment, do not admit the employment of worm gear. A bugbear with many has been the supposed waste of power in friction by worm gear. The facts are generally the other way. If a series of worm gears had to be employed to gain the required reduction, there might be truth in this assumption of wastefulness. In general, a single worm gear will reduce speed as much as could be practically accomplished with three or four pairs of spur or bevel gears, and, although a single worm and wheel probably will give a higher co-efficient of friction than a single pair of ordinary gears, the total consumption of power by such mechanism may well be less than that of the more complicated gearing. In the *American Machinist's* article are given the average results of tests made to determine the efficiency of this mode of transmission. These tests were made by the Sprague Elevator Company, which employs worm gearing in operating electric elevators, and were made with a balanced double worm, which avoids longitudinal thrust of the worm in either direction. The results are presented in two diagrams, one of which is for the Hindley worm and the other for the common worm. The curves on the diagram for the Hindley worm indicate the electrical output, the mechanical output, and the efficiency. The diagram shows only the curve of efficiency, a comparison of which with that for the Handley worm is much in favor of the latter. The ordinates of these curves represent amperes of current, and percentage of efficiency; the abscissas represent the pounds of pressure on the worms. The curve of mechanical output represents work actually done in hoisting the various weights,—translated into equivalent current. The mechanical-power output is, of course, the product of the weight lifted by its speed, while the electrical power input is the product of the volts by the amperes. The speed and voltage are fixed, and hence may be ignored, or, more properly speaking, canceled, and the weights lifted compared directly with the amperes supplied." The results of more extended tests, with worms of different pitches, intended to show the effect of variations of pitch, are promised from the same source at an early day, and the data to be thus supplied will have a much wider interest than they would have had prior to the present extended use of electric motors.

The Purification of Water.

Dr. Frank J. Thornbury, in *The Chautauquan* for February, says that, in the absence of bacteria from water which comes from artesian wells and springs after its percolation through the earth, there is an important suggestion of means for improving the character and potability of water. Dr. Thornbury is a lecturer on bacteriology in the University of Buffalo, and is a recognized expert on this subject. He says that the forces of gravity and capillarity explain the process, minute capillary streams being formed which run in all directions through the soil. When the coarse texture of the soil is considered, it is, perhaps, rather to be wondered at that greater numbers of bacteria are not carried into the lower strata, but the depth of the soil through which the water percolates before it again reaches the surface explains this discrepancy. The huge sand-filters employed in a number of municipalities, both in America and Europe, are, therefore, merely more or less close imitations of nature's method, and, in proportion as they approximate to that method, their success has been greater or less. Most of them can hardly yet be regarded as brilliant successes, although the water so treated not only has been improved, but in some cases has been brought to a condition permitting its use for domestic purposes. Nature's great method of purifying water is filtration. This means not merely the removal of the floating particles that may be mechanically obstructed by the sand particles, but also those minute living germs that would readily pass through a small filter of almost any material. "When we consider the fact that a number of natural water-supplies which were originally pure have become, as the penalty of increasing population, virtually diluted sewage, we must realize the extent of refuse which will accumulate in one of these filter-beds after only a short usage. And, strange to say, it is the mechanical action of this sediment itself, which swarms in low forms of vegetable life, that is to improve the filtering capacity of the sand-bed. The sediment occludes the pores which will be present in even the finest sand obtainable. A filter like the foregoing is, then, simply a dense bed of bacteria and slime, composed largely of vegetable degenerated substances. Notwithstanding all this, water which passes really seems to improve as regards the number, at least, of the bacteria which it contains. But, as the bacteria which appear in the effluent are not entirely a residue of those which have entered, but rather represent organisms which have been washed from the deeper portions of the filter, we may readily see that, if the filter had been contaminated by a transitory passage of foul sewage containing perhaps pathogenic organisms, water might be deteriorated rather than improved in its quality. Where such a system of purifying water is employed, the water should be sedimented for two or three days by simply allowing it to stand, so that some, at least, of the impurities—gross and bacterial—will be disposed of and the filter given less to do." One of the important facts pertaining to the use of filtered water, which should be impressed upon the minds and memories of all who use such water, is the fact that bacteria rapidly reproduce and multiply in it. Hence such water should not stand long before its use for any purpose concerned in the preparation of food. Dr. Thornbury holds that efficient filtration is rather a biological process than a mechanical one, and that, the sooner this fact is realized, the sooner will the much-needed improvements in artificial filtration be made. Nature's filtration is intermittent, and "the value of intermittent filtration in the disposition of sewage by the sewage-farm system has been amply illustrated by experiments conducted under the auspices of the Massachusetts board of health." The author sustains Wyatt Johnson's assertion that ninety per cent. of all domestic filters are absolutely unreliable, and that the remainder are good only when cleaned and sterilized at least once a week.

The Operation of Long Electric Railway Lines.

PROFESSOR S. H. SHORT, in *The Electrical Engineer* (Jan. 6), makes some interesting practical suggestions upon the operation of long, interurban, electric railway lines. Noting an increased demand for heavier equipment and higher speed in this sort of traffic, and the facts that this demand has brought into existence "double-truck passenger coaches equipped with motors ranging from fifty to one hundred horse power," and that several roads in the United States are running trains of from two to three of these cars, which, by the overhead trolley system, are brought into the hearts of cities over the ordinary surface lines of the street railway companies, he points out the difficulty "that apparatus for this suburban traffic must be constructed to develop much greater speed than can be permitted within city limits. In existing practice, two motors of large size are used and regulated by an ordinary series multiple controller. If these are geared to run forty miles an hour at full speed on the parallel position of the controller, their minimum speed would be twenty miles per hour on the series position, unless considerable rheostat resistance be included in circuit, which is both wasteful of energy and destructive to the resistances themselves." Instead of using two motors, Prof. Short suggests four smaller ones, one on each axle of the motor car, and the employment of a controller which, "when the motors are grouped in parallel, will develop a speed of forty miles per hour, in series parallel a speed of twenty miles an hour, and in series a speed of ten miles an hour," the latter being the maximum speed now permitted in city streets. If this suggestion were carried out, several important advantages would result. Among these are increased adhesion—twice as many wheels acting as drivers. To obtain the requisite current from the supply conductor, several ways are indicated. "Two or more trolleys may be arranged, one behind the other, and connected in parallel, each taking its portion of current from the trolley wire; or, perhaps better, a single trolley with a cylinder of some length attached to the upper end of the trolley pole, making contact with two or three current-carrying trolley wires. These trolley wires would be connected in parallel, and would reduce the size of the feeders of the line. Over switches and sidings these wires could be separated, as one wire could carry sufficient current for any short distance." The overhead trolley system, however, is regarded as impracticable for long distance, cross-country roads, which must rival steam railways in weight and durability of equipment. For roads of this kind the "third rail" system is advocated, this rail to take its current from a main extending the full length of the road, to be placed in a conduit at one side of the track, and to convey current to the motors by means of contact shoes attached to the front and rear trucks of the motor car. Prof. Short regards alternating motors as, in themselves, solving part of the difficulties here outlined, provided some way can be devised to increase the torque needed for starting. This point is receiving attention, and the defect has been overcome in some measure. A great advantage of the alternating current motors is the practicability of regulating speed on different sections of the road. But the adaptation of alternating current motors to street-railway propulsion presents such difficulties that, as yet, the direct current motors have the field. Should the direct conversion of the potential energy of carbon into electrical energy prove to be something more than a chimera, the problem of electrical propulsion for railways would be vastly simplified. We are of those who believe that this will at some time be accomplished, notwithstanding the cold water which some electrical authorities of influence and standing have of late thrown upon what has already been done in this direction.

The Electric Yacht Utopian.

A BRIEF illustrated description of this yacht appears in *American Electrician* for January. The article deals as much with the marine engineering features of the boat as with its electrical outfit. The latter is chiefly remarkable because the largest storage-battery ever installed for boat-propulsion has been supplied to the vessel. Of course, there are numerous electrical appliances. These, however, are now common on board vessels of this class, and little need be said about them. The construction of the hull presents novelty. The boat's length is 72 feet, beam 12 feet, and draft 12 feet. She was designed by Mr. Charles D. Mosher, and built in Ayres' ship-yard at Nyack on the Hudson.

The propellers are placed in channel-ways arranged to give the screws solid water to work in. The screws are capable of a speed of twelve hundred turns per minute. We believe that such a speed for these screws will prove less efficient than a less speed and larger screws. The appearance of the model at the stern is peculiar, on account of this channel-way construction. A difficulty attends this arrangement of screws in channel-ways, when boats are intended to ply in waters prolific in aquatic plants. The screws are liable to entanglement. Two Tobin-bronze center-boards, one placed about one-third the vessel's length aft of the bow, and the other about the same distance forward of the stern, are supplied. A separate 25-h. p. Riker motor is directly connected with each screw shaft. "The storage-batteries are of a new system, having no grid plates, and furnished by the Samuels Dynamic Accumulator Co., of New York. The positive plate is solid, and very hard and dense, and is said to improve in its durable qualities with use. Each cell has eleven plates weighing twenty-six pounds, the cell complete, with electrolyte, weighing only fifty pounds. Each cylinder has its own controlling battery, the latter being of 300 ampere hours' capacity, and consisting of 204 cells. The cells are divided into 6 independent groups of 17 pairs of cells each—each pair being parallel, and the 17 pairs in series, thus giving 34 volts for each group. Six groups, by means of the controller, can be thrown into four different combinations, . . . and the motor field may either be in series or parallel, which gives eight different speeds for the propellers. . . . The first four combinations are employed for both backing and ahead, and the latter four for ahead alone." The boat will also be schooner rigged, and can thus be propelled by wind, if occasion demands.

Allotropism of Iron.

THIS subject, which appears to come up for discussion from time to time, is again considered by Mr. Henry M. Howe in *The Engineering and Mining Journal* (Dec. 12). As proof "that iron becomes allotropic in the broad sense of the word, in the critical range of temperature," he cites the fact that iron "nearly chemically pure and apparently free from carbon, in cooling slowly through the critical range of temperature, regains its magnetic properties rapidly, and twice spontaneously emits heat at definite, well-marked temperatures.

The important question whether the retention of this allotropic iron by sudden cooling be one cause of the hardening of steel would be answered affirmatively, if it could be shown that some of the effects which we group together under the general name of hardening can be produced under such conditions that no cause other than this known allotropy suffices to explain them." In a former paper, read before the Iron and Steel Institute, Mr. Howe presented a number of cases wherein iron containing a very small percentage of carbon was strengthened and embrittled to a degree which in his opinion was too great to be attributed to the carbon. Thus steel containing only 0.06 per cent. of carbon had its tenacity nearly tripled. Another instance is cited wherein "iron containing only 0.02 per cent. of carbon and very little manganese or any other element had its tenacity increased by 35 per cent., and its elastic limit raised by 81 per cent., by a cooling which was only moderately rapid." Following this are tabulated results of a series of experiments carried out at the works of the Pennsylvania Steel Company with bars of equal size cut from a block of steel containing only 0.04 per cent. of carbon, such of these bars as were quenched showing a much greater tenacity than those that were cooled slowly. He admits that these results *may* be "due jointly to the direct action of the foreign elements so sparingly present, and to stress and other causes yet unsuggested;" but he thinks it "as difficult to explain them in this way as it is easy to explain them by supposing that the allotropic iron . . . has been in part retained by the rapid cooling," and that allotropic iron "is stronger, but less ductile, with higher elastic limit, than iron in the normal state reached by slow cooling."

A Plea for Simplicity in Plumbing-Work.

We are in receipt of a pamphlet written by Mr. Wm. Paul Gerhard, a civil engineer who has given a great deal of attention to the heating, ventilating, drainage, and sanitation of dwellings and public buildings, and who has made a specialty of sanitary engineering. Mr. Gerhard is also widely and favorably known from his numerous treatises and papers on sanitation and kindred topics; therefore the opinion he expresses in the particular pamphlet here noticed, entitled "Plumbing Simplified," will command attention. Doubtless the view that a simpler and less costly system of plumbing than is now practised can be made equally serviceable and effective will be combatted, especially by those whose commercial interests lie in maintaining the use of current appliances. If, however, Mr. Gerhard has fortified his view by irrefragible arguments, the employment of simpler modes will be only a question of time. Early in his essay the author makes an avowal of his advocacy of good, sound, and safe plumbing-work, and puts in a disclaimer of any "personal interest in any patented plumbing device or in any special trap," thus defending himself in advance against a suspicion that his views are biased by motives which such an interest might create. The law that "all traps must have a vent-pipe of suitable size connected at or near the crown of the trap, and extended separately up to the roof or connected with the soil-pipe line above the highest fixture," first put in force in New York, Boston, and some other cities, has been widely copied by many smaller cities and towns, which action is regarded by Mr. Gerhard as a mistake. He makes the following objections to this law: "(1) The venting of traps leads to a greater, and sometimes dangerous, complication of the work; (2) it involves a useless outlay of money; (3) it increases, and often doubles, the number of pipe-joints in a building; it duplicates the pipe system, and therefore increases the danger of leakage at the joints; (4) trap vents attached to the horns of porcelain fixtures, such as water-closets, often lead, in case of settlement of the building, to the breakage of these horns, thus opening up a dangerous inlet for sewer air, the crack often remaining unnoticed for years; (5) the mouth of the vent-pipe at the point where it attaches to the crown of the trap is liable to clog up with congealed greasy deposit, rendering the vent-pipe useless without this fact becoming apparent to the occupant of the house; (6) the upper end of the back air pipe, when it extends separately to the roof, is liable, unless enlarged to at least four inches in diameter, to be closed up with snow or hoar frost in winter time; in very cold climates even a four-inch pipe may become sufficiently obstructed by hoar frost or icicles to impede seriously the free ventilation of the vent-pipe; (7) owing to the increased air current passing over the water-seal of the trap, and induced by the vent-pipe, the destruction of the water-seal by evaporation is more rapid; (8) the trap venting system affords increased opportunities for bye-passes in the case of careless or ignorant workmen; (9) in the case of long vent-pipes, particularly where there are several sharp bends in the pipe, the friction of the air passing through the pipe is sometimes increased to such an extent that the vent-pipe fails to protect the trap from siphonage." Surely here is an array of objections to the system of trap-venting that challenges serious attention. The author, while he uses with the simple S-trap a back air pipe for preventing siphonage, asserts his belief that "branch-pipe ventilation is carried much too far"; that "it creates new and sometimes serious dangers"; and that "it entails an unnecessary and useless expenditure of money." To the argument that trap-vent pipes are not alone for the purpose of preventing siphonage, but also for aerating branch pipes and maintaining circulation of air in the entire system of branches, the answer is made that "plumbing-work can, and should, be always skilfully arranged and planned, so that the fixtures are located immediately adjoining well-ventilated soil- or waste-pipe lines. If thus arranged, the short branches will be so well flushed by the frequent discharge from the improved modern fixtures with large outlets—each of which constitutes in itself a small flush-tank—as hardly to require any other purification or aeration." And he urges that only fixtures having the features named are suitable for plumbing-work. A description of the simplified method illustrated by diagrams can not be here reproduced, but it appears to confirm the claim that this method is generally practicable. Rules desirable to observe when planning the system are given. Finally, the author claims to be able to prove experimentally that "security against back pressure, loss by momentum, evaporation, siphonage, and loss of seal by capillary attraction may unquestionably be attained by the method described." The paper is both progressive and aggressive. It closes with a prediction that "the trap-vent law will ultimately be repealed, and that simpler and better methods will take its place." If the system proposed by Mr. Gerhard is better than, or, as we are willing to concede, even as good as, the trap-vent system, its superior cheapness is sure to force it to the front.

Cost of Boiler Attendance.

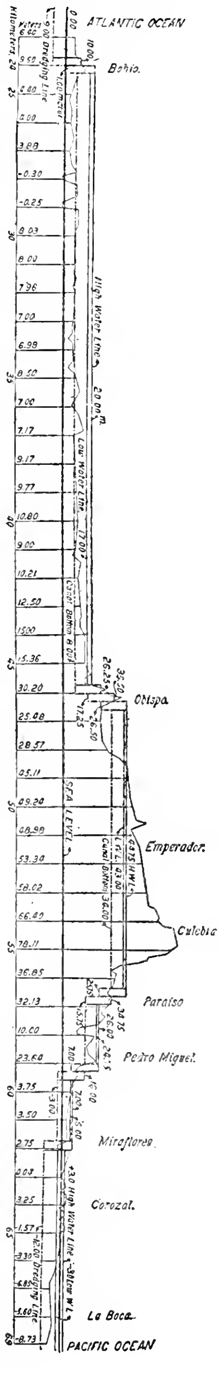
LIGHT has been thrown upon the subject of boiler-room economy by information contained in circular No. 6, of the Steam Users' Association. Investigations disclose the following facts. The average cost of handling coal in boiler-rooms is forty-five cents per ton, the minimum cost twenty-six cents, and the maximum eighty-five cents. The maximum is, therefore, very nearly four times the minimum. While the contention of the circular that this indicates the possibility of improving methods of handling coal in supplying fuel to boilers may be readily admitted, practical men will see that the question of cost in handling must depend in considerable degree upon the quantity daily consumed. This has not been overlooked by the investigators in the conclusions arrived at. These conclusions are not put forward as rigidly accurate, but as sufficiently close approximations to answer the purpose of their publication. Those who have not received the circular will find these conclusions systematically printed in due order in *Engineering News* (Jan. 28).

Electric Arc for Lantern Projection.

THOSE who desire to use lantern projection in illustrating lectures will find some useful hints upon the use of the arc-light for this purpose in the first number of a series of articles by E. P. Hopkins, commenced in *The Electrical Engineer* of December 12. The illuminants hitherto used for this purpose have been oil lamps; illuminating gas, used with the argand burner, and, later and better, with the Welsbach burner; acetylene gas; the oxyhydrogen or calcium light; the electric incandescent light; and, last and best of all, the electric arc light. Mr. Hopkins' first article describes a method of obtaining the most satisfactory results from the arc-light The conditions to be attained are the illumination of the slide as uniformly as possible, and the use of as small an illuminant as possible. The first condition is obtained with a short focus by means of two condensing lenses, and the illuminant can be reduced more nearly to a point in the electric arc than by any other known means. The mounting of the condensing lenses must be such as to permit their expansion when heated, and, with a current of from seven to eighteen amperes, a combined focus of three inches with a pair of condensing lenses is perfectly safe. With the electric arc such an arrangement can be made that, at the extreme point of the positive carbon, an area of three-sixteenths of an inch in diameter will emit eighty per cent. of the entire light; and, by tilting the lamp so that the extremity of the positive carbon points toward the condensing lenses, the spot of light from the negative carbon can be avoided. The concentrated rays may be passed through an aperture of one-eighth inch in diameter,—a necessity in microscopical projections.

The New Panama Lock Canal.

FROM our excellent contemporary, the *Railroad Gazette* (Jan. 15), we are able to able to make an abstract of the present status of the Panama canal scheme as an engineering enterprise. That journal prints an illustrated article upon the subject, with a profile, which we reproduce on a somewhat smaller scale.



The profile is that of the plan now provisionally adopted, which contemplates the utilization of the work already accomplished. "The elevation of the summit level (bottom of channel) will be thirty-four meters above mean sea level. Though this elevation of thirty-four meters is adopted as a starting-point for the proposed work, it is not to be considered as unchangeable. The company will endeavor, either during its investigation or while the work is in progress, to lower, as far as possible, the channel at the divide below this elevation of thirty-four meters, should the conditions for excavating the large cutting which will constitute the divide be found favorable." On the Atlantic side the tide is not sufficient to demand consideration, and the harbor channel on that side will be at about the sea-level. At the Pacific end a variation of six meters between high and low tide must be allowed for. To reach the elevation of thirty-four meters above the sea-level will require a rise from the channel-bottom of forty-three meters on the Atlantic, and forty-six meters on the Pacific, side. Five locks—maximum lift 10 m.—on each slope will be used to get the required rise. "On the Atlantic slope are two successive locks at the kilometric point 24, at Bohio Soldado, and three successive locks at the kilometric point 46, at Obispo. On the Pacific slope are one lock at Miraflores, kilometric point 62; two successive locks at Pedro Miguel, kilometric point 59; and two successive locks at Paraiso, kilometric point 56.500. "The successive levels will be determined by the locks, and by the dams which close the valleys transversely where the locks are to be placed. These locks will, therefore, form lakes of varied extent to receive directly the waters for the canal. The only really important one will be the one for the locks and dams at Bohio. This lake, which will have a surface of about 1.16 square miles, will receive, besides the Chagres river, whose flow is to be regulated by a higher lake, . . . the tributaries of the stream of water between the summit level channel and the dams in the valley at Bohio. . . . The discharges from the lake will be led through special waterways below the dam." The supply of water for the locks will be taken from the Chagres river, for which purpose a scheme of regulation and control of floods has been worked out. The locks will be constructed to take in the largest trading vessels. The width will vary, and locks and basins will be provided to facilitate the passage of vessels through the canal. The statement is made that the company has taken all necessary measures for the rapid progress of the work, the successful completion of which is expected in about two years from the present time. We may hope, thus, to have the two oceans connected before the beginning of the twentieth century.

A Metric-Conversion Table.

THE January issue of *Engineering Mechanics* contains a very handy metric-conversion table compiled by Mr. C. W. Hunt, of New York city. The particular convenience of this compilation is the expression of the factors in such form that the conversions ordinarily required may be effected by one direct operation of multiplication.

The table is reproduced below. *Engineering Mechanics* states that Mr. Hunt has had copies prepared, which he will furnish on request if stamps are enclosed.

Millimeters × .03937 = inches.
Millimeters ÷ 25.4 = inches.
Centimeters × .3937 = inches.
Centimeters ÷ 2.54 = inches.
Meters = 39.37 = inches (Act of Congress).
Meters × 3.281 = feet.
Meters × 1.094 = yards.
Kilometers × .621 = miles.
Kilometers ÷ 1.6093 = miles.
Kilometers × 3280.7 = feet.
Square millimeters × .0155 = square inches.
Square millimeters ÷ 645.1 = square inches.
Square centimeters × 1.55 = square inches.
Square centimeters ÷ 6.451 = square inches.
Square meters × 10.764 = square feet.
Square kilometers × 247.1 = acres.
Hectares × 2.471 = acres.
Cubic centimeters ÷ 16.383 = cubic inches.
Cubic centimeters ÷ 3.69 = fluid drachms (U. S. P.).
Cubic centimeters ÷ 29.57 = fluid ounce (U. S. P.).
Cubic meters × 35.315 = cubic feet.
Cubic meters × 1.308 = cubic yards.
Cubic meters × 264.2 = gallons (231 cu. in.).
Liters × 61.022 = cubic inches (Act of Congress).
Liters × 33.84 = fluid ounces (U. S. Phar.).
Liters × .2642 = gallons (231 cu. in.)
Liters ÷ 3.78 = gallons (231 cu. in.).
Liters ÷ 28.316 = cubic feet.
Hectoliters × 3.531 = cubic feet.
Hectoliters × 2.84 = bushels (2150.42 cu. in.).
Hectoliters × .131 = cubic yards.
Hectoliters ÷ 26.42 = gallons (231 cu. in.)
Grammes × 15.432 = grains (Act of Congress).
Grammes × 981 = dynes.
Grammes (water) ÷ 29.57 = fluid ounces.
Grammes ÷ 28.35 = ounces avoirdupois.
Grammes per cu. cent. ÷ 27.7 = lbs. per cu. in.
Joule × .7373 = foot pounds.
Kilograms × 2.2046 = pounds.
Kilograms × 35.3 = ounces avoirdupois.
Kilograms ÷ 1102.3 = tons (2000 lbs.).
Kilograms per sq. cent. × 14.223 = lbs. per sq. in.
Kilogrammeters × 7.233 = foot pounds.
Kilograms per meter × .672 = pounds per sq. ft.
Kilograms per cubic meter × .026 = pounds per cu. ft.
Kilograms per cheval vapeur × 2.235 = lbs. per h. p.
Kili-watts × 1.34 = horse power.
Watts ÷ 746 = horse power.
Watts ÷ .7373 = foot pounds per second.
Calorie × 3.968 = B. T. U.
Cheval vapeur × .9863 = horse power.
(Centigrade × 1.8) + 32 = deg. Fahrenheit.
Francs × .193 = dollars.
Gravity, Paris = 980.94 cent. per second.

THE BRITISH PRESS

The Status of Civil Engineering in England at the Beginning of 1897.

A RETROSPECT of the past year's progress in civil engineering and an attempt at forecasting its future for the current year fills several editorial columns of *The Engineer* (London, Jan. 1). This editorial asserts that the British engineers do not retain the prestige they once possessed among continental nations, but it does not blame them for the decadence. This is attributed to various causes, among which are included the endeavors of purely theoretical professors and tutors "to force upon the" (British) "working men and youth . . . an alien system of education, defective *per se*, theoretical to the point of absurdity, and repugnant to the feelings and sentiments of those for whose benefit it is supposed to be intended." There is here an intimation—amounting almost to positive assertion—that a scale of education may be raised too high—so high, in fact, that it will be rejected. "Raise the standard of education as high as the Himalayas, or higher if possible, but, if it is not a scale 'understanded of the people,' they will have none of it." This alleged attempt is called "a fatuous blunder," resulting in a diminution of eagerness in the search for knowledge on the part of the British public. Exactly how this "fatuous blunder" has resulted in the loss of continental prestige is not made clear; but it is frankly conceded that the field for the enterprise and talent of British engineers, as compared with that of a former period, has been much contracted. As a fact of the end-of-the-century tendencies this contraction is discussed, not as a cause for discouragement, but as a development that ought to have been foreseen and discounted. It was not possible for British engineers to create and maintain so broad a demand for their services as at one time prevailed; and, while there is still room for the exercise of their skill, both in the United Kingdom and to a less extent on the continent, they are now advised to go further afield. India, Canada, Australia, and the numerous other British possessions are spoken of as likely to supply the desired scope and opportunities for the rising generation of English engineers. Some self-congratulation upon the number and extent of these dependencies is indulged, and the advantage they afford to British talent as compared with the comparatively meager possessions of continental nations is dwelt upon in a brief forecast of the probable results of modern improvement in these far-off lands. The humiliating reflection that, while Great Britain has been active in the acquisition of territory,—thus enlarging the scope of effort for native-born Englishmen,—the United States government has been giving away its domain to foreigners and aliens, thus restricting the opportunities of its native-born citizens, has been painfully forced upon us in this review. Of all the great nations of the earth, the United States alone has committed this monumental folly.

Cottage Architecture.

AN agreeable and thoughtful article on this subject by Mr. Ralph Neville, in the *Journal of the Royal Institute of British Architects* (Dec. 31), presents a discussion under the following four heads: (1) Accommodation; (2) the style; (3) the plan; (4) the material. We have long thought that cottage architecture affords a field for the exercise and cultivation of artistic feeling which, if not equal to the possibilities of large, stately buildings, may confer gratification upon those whose taste has not had the broadest opportunities for cultivation, as well as upon those who are landscape artists in the full sense of the word. A cottage and its surroundings, no matter how humble or inexpensive, may form so attractive a picture that even a trained artist would take pleasure in beholding and studying the secrets of its charm; the more highly trained the artist may be, the more likely it is that he will delight in charming effects produced in the simplest way. A true lover of beauty does not gage his fee of admiration by any social or conventional scale whatever. A difficulty which usually accompanies the design of a cottage—the slender sum which can be devoted to the building—seems to a class of mind somewhat above the monotonous plane of money-making to add to the interest of the subject. The art of making beautiful that which is at the same time inexpensive seems to be art the cultivation of which the whole mass of humanity would benefit by. The cottages treated by Mr. Neville are of the humbler order, such as are occupied by rural laborers; and Mr. Neville throws a dash of good sense into his paper almost at the outset, when he deprecates as futile and foolish the efforts of some to induce cottagers to use their best rooms for ordinary purposes. "Experience convinces one of the necessity of bowing to one of the deepest seated instincts of cottage-dwellers." The question is whether cottagers are to have a kitchen as well as a scullery big enough to be turned by squeezing into a working kitchen. "The kitchen will then infallibly be turned into a parlor, which will be shut up except on Sunday afternoons or to receive the visits of 'the quality.' . . . Certain it is that they will leave a large, roomy cottage of the old sort for a modern one where they can have this luxury." Of style it is maintained that the straining for effect through the sacrifice of simplicity should be strongly deprecated. It adds to cost without any adequate return, and employs money that ought rather to be applied to making the interior more comfortable. In proportions, rather than in ornamentation, pleasing effects are to be sought. A plain exterior (except that some attention may be bestowed upon the front windows), roofs sought by lichens and low eaves by creepers, may be made to satisfy the eye of taste much more completely than the fantastic shapes by which many designers seek a beautiful effect, which they never obtain by such means. The plan of modern laborers' cottages mostly follows the line of erection in pairs, or in blocks of four, the purpose being economy in chimney stacks. The design of interiors, which Mr. Neville discusses at some length, has evidently been very carefully considered. The reader who desires to follow all these details must consult the article itself. Of materials, although locality will much influence selection, one particularly is recommended as everywhere available and in every way adapted to the purpose. This material is concrete, and its convenience and value are strongly asserted. Some remarks on the restoration of old cottages conclude the article.

Progress in Electric Engineering from an English Standpoint.

In a rapid review of electrical work during 1896, *The Engineer* (London, Jan. 1) notes that there has been a very satisfactory increase of business in this field, and that at the commencement of the present year a very large number of electrical engineering establishments had orders for all they could possibly do for a period of six months. All indications point to equal prosperity in 1897. Electric lighting has a preëminence in England over other branches of electrical engineering. The country does not possess numerous and large sources of water power, which can be advantageously and profitably distributed by the electric current when generated, as is the case in North America and other parts of the world. Distribution of mechanical power therefore holds in England a place far below that which it holds in the United States. In electric lighting municipal control appears to be the rule in England, and there is apparent a strong tendency in its favor. In the United States many (including this magazine) believe that municipal control would ultimately result in a less satisfactory and a more expensive supply than is now obtainable from the electric-lighting companies. But the opposite is alleged to have been the outcome of municipal control in England. The system has in some cases imposed delay in obtaining the desired supply; but in nearly all cases it has resulted in the employment of a competent engineer, under whose advice well-designed and thoroughly-equipped stations have been installed. While in some instances gas-works and electric-lighting plants are worked together, experience is proving that this is not the best plan, and there is a growing tendency toward a policy of separation. "As a rule," says our cotemporary, "there is quite sufficient room for the development of both sources of supply." Where, as in Belfast, gas departments supply gaseous fuel to the electric-lighting plants, the arrangement is said to have been, in some instances, at least, not altogether satisfactory. On the other hand, the employment of special producer-gas plants to supply power for electricity stations appears to be of great promise. Of this system it is asserted that it has given the lowest coal consumption yet attained. Several stations working upon this system are named, and results attained in them have presumably contributed to the favorable opinion expressed. The state of opinion among the designers of central-station steam-generating plants regarding many things (for example, the best type of boiler, and the economy secured by superheating steam) is still unsettled. Of superheating it is said that "considerable discussion has taken place as to whether the economy that appeared to be obtained was actually due to the system of superheating employed; and so far no trustworthy data are obtainable which will prove whether superheating *per se* is so economical as would appear, or whether the particular results set forth are due to the type of generating plant in use. It has always appeared to us somewhat strange that such a diversity of opinion should exist between the designers of central-station steam-generating plant and the designers of similar plant for mill work and other purposes of the same nature. The latter appear to have long since decided in favor of the Lancashire boiler, while there seems to be no unanimity whatever in the designs of the former. . . . No unanimity is as yet evident in the type of plant selected for the generation of electricity, although there appears to be a tendency to use large fly-wheel alternators for the generation of alternating currents in preference to the use of belt or rope-driven machines running at higher speeds." The results so far attained by rectification of alternating current are not yet regarded as convincing evidence that they warrant the extra attention demanded in the application of this system. It is thought that a potential of two hundred volts will soon become the standard of supply from direct-current stations; and attention is directed to the increased care needed in the wiring of buildings for electric lighting which this increase of voltage will demand. Electric heating and cooking have as yet made small progress in England. Notwithstanding the probability of a great future for the fly-wheel alternator in producing alternating current, our contemporary still believes direct-driven plants for direct currents will be most desirable. Gas engines working with producer gas and driving dynamos direct are among the probable competitors of steam engines for electric-lighting plants. One installation of this sort (developing 164 brake horse power) is spoken of as working satisfactorily. It is believed that a considerable extension of electric tramway construction will soon be witnessed in England, as electric power for this purpose is growing in favor. Electric welding is also gradually extending, and the outlook for general electric engineering is very bright.

The Bearings of the Marine Engine.

WITH increased steam pressures and increased power for propelling ships the difficulties with bearings have been much increased,—difficulties which those inexperienced with marine machinery would scarcely credit. It was said of the ram Dunderberg, after her purchase by the French government, that, during her passage across the Atlantic, her bearings could be kept moderately cool only by a constant deluge of oil and water; in fact, provision for cooling bearings with jets of water is a common feature of modern marine engine construction. In a paper read before the Institute of Marine Engineers by Mr. John Dewrance, the author presents the results of an experimental study of lubrication under heavy loads, and of the manner in which oil enables a bearing to support its load. The method adopted—which is illustrated in the paper as printed in *Engineering* (Jan. 1)—consists in the employment of a wheel twenty-four inches in diameter and representing a shaft, a flat plate which may represent an enlarged bearing, and a trough placed in such relation with the wheel that oil placed therein may rise to the plane of the bearing surface of the wheel. Before putting the oil in the trough, if a micrometer be adjusted to indicate the position of the wheel, its index will stand at some determinate mark. "If oil is now put into the trough so that it touches the wheel, it will be observed that the hand has moved, showing that the plate has risen. This means that between the surface of the wheel and the bearing there is a layer of oil on which the bearing is floating. If we now load the bearing, we must either squeeze out this layer of oil, or the oil must be subject to a pressure sufficient to support the extra load. By means of a hole through the bearing and a pressure gage, this point can very readily be proved. As will be seen, as the hole is brought to the point of contact between the bearing and the shaft, the pressure on the gage rises to a point that corresponds to the load put upon the bearing. . . The oil adheres to the surface of the wheel or shaft, and the force of this adhesion is multiplied by the incline formed by the bearing to the shaft. If the hole is put beyond the center of the shaft, the air in the hole adheres to the shaft and is carried around, leaving a vacuum as shown by the gage. Under favorable circumstances this vacuum has amounted to thirty inches of mercury column." The conclusion cannot be avoided that bearing surfaces properly lubricated with oil are separated by a film of oil under a pressure per square inch corresponding with the load (per square inch) to which they are subjected. The secret of good lubrication is, therefore, the introduction of oil to the bearing surfaces at points of least pressure, and the prevention of its escape from points of greatest pressure. Mr. Dewrance thinks it easy, in general, to find out the points of least pressure on a bearing, and to bring the oil to these points by the exercise of a little ingenuity. Holes and channels designed to assist lubrication not unfrequently defeat the purpose they are designed to subserve. Oil-holes and channels at the crown of the bearing, where pressure is greatest, are worse than useless. "When the pressure on such a bearing is intermittent, the oil goes in when the pressure is taken off, and escapes out again when the pressure comes on, the effect being that the bearing is able to support only a portion of the load that it could have sustained," had holes and channels been made at points of least pressure. "It is quite impossible to lubricate such a bearing at all, if subjected to a continuous load. Not a drop of oil will run down the hole at the crown of the bearing, and, if oil is put on the shaft elsewhere, it runs out at the hole at the crown." Having considered these underlying principles, the author describes and illustrates their application to the bearings of a marine engine and propeller shaft. In the case of the thrust-block, as commonly constructed, there is no point of least pressure at which the oil can be introduced, but such a provision may be made by slightly sloping off the edges of bearing surfaces, which, Mr. Dewrance declares, will, when so formed, draw the oil in between the surfaces up to any pressure.

"Another very important point is the material of which the bearing is composed. Marine engineers seem to be very generally agreed that the bearing should be lined with one of the alloys known as the white metals. These may be divided into three classes. The first contains anything up to eighty per cent. of tin, the second anything up to eighty per cent. of zinc, and the third anything up to eighty per cent. of lead. If we could make sure of always using perfectly neutral oil, there would be very little to choose between these three classes; but, to obtain a neutral oil, such as is prepared for clock-makers, the oil is agitated with zinc and lead shavings, and a portion of each is converted into zinc or lead soap, which is afterward separated from the oil. The principal impurity of lubricating oils is oleic acid, which rapidly corrodes lead and zinc. . . The effect, then, of using an alloy that contains a large proportion of lead or zinc is that the impurities of the oil combine with the surface of the bearings. Of course, this may be avoided by using a very pure oil, but those that are responsible for the lining of the bearing are not always responsible for the quality of oil used, and, even if they are at the time, they can not make sure that they will always have it under their control. Tin is not affected by oleic acid or any of the impurities of oil; so the safest way is to use an alloy composed principally of tin, and containing only enough of the most suitable metal to harden it to the utmost." Alloys that yield under a load of less than five tons to the square inch are too soft; "the best alloys will bear eight tons without yielding." The alloy should be hard enough without hammering. Hammering is disapproved, because, if the metal be as hard as it ought to be, hammering fills it with minute cracks, and, if so soft as to require hammering, it should not be used at all for the lining of marine bearings.

Brickwork Tests.

THE uncertainties and discrepancies that attend tests of the strength of brickwork are very forcibly exemplified in the following table, extracted from an editorial upon the subject in *Engineering* (Jan. 1). One of the very ablest experimenters in the United Kingdom, Prof. Unwin, made the tests from which the data are taken, acting for the Institute of British Architects. An inspection of the table reveals these discrepancies. One of the reasons why so widely-varying results are obtained in almost any extended series of brickwork tests is the great variety of conditions. The quality and mode of application of the cement or mortar in which the bricks are laid; the nature of the weather while the wall is going up; the rapidity, thoroughness, or lack of thoroughess with which the work of bricklaying is done; the quality of the bricks used, —all these are factors in the final strength and enduring power of the structure when finished and tested. This is but to repeat what is well-known to all designers and builders of brickwork. All the same, most engineers, architects, or masons, setting out to attain a prescribed factor of safety in a brick structure,—say, an arch, —would attain the end by giving it a strength known, or reasonably assumed, to be in excess of the strength specified, and would shrink from working from a calculation that theoretically confined the factor to so narrow a margin of error as would be permitted in a machine built of steel or cast iron. The iron and steel worker has the advantages that much greater accuracy in results can be secured in testing the quality of the material used, and the confidence that, when this strength is determined, it may be relied upon to present a fair degree of uniformity. On the other hand, the mason, even if he be satisfied that the quality of the cement used is good, and that it is tolerably uniform throughout, immediately finds himself confronted with the personal equation of the workmen, variations in temperature, changing hygrometric conditions, etc., each of which is almost sure to affect the final result more than one, or all, of them are ever likely to influence a job performed in a machine-shop under faithful and competent direction. The table which has called out the above remarks here follows:

Table of Brickwork Tests.

Material of Pier.	Crack'd at	Col-lapsed at	Average Strength of Single Brick
	tons per sq. ft.	tons per sq. ft.	tons per sq. ft.
London stocks in mortar..........	4.18	10.41	84.27
London stocks in cement..........	7.22	16.03	
Gault in mortar. .	5.00	21.82	182.2
" " "	6.16	23.03	
" " cement....	6.98	17.98	
" " "	7.08	17.51	
Leicester red in mortar..........	15.20	29.93	382.1
Leicester red in mortar..	16.11	31.55	
Leicester cement....	17.87	67.36	
" "	21.82	49.54	
Staffordshire blue in mortar	22.43	69.22	701.1
Staffordshire blue in mortar..........	21.42	79.39	
Staffordshire blue in cement..........	29.45	84.47	
Staffordshire blue in cement..........	18.91	61.14	

Engineering points out that, "if these figures can be considered in any way generally applicable" (this sounds strangely in speaking of data supplied by a man of Prof. Unwin's reputation), they show "how inaccurate is the common assumption that the factor of safety for masonry is 15 or 20. It is, however, important to note that in no single instance did the piers in question fail by direct crushing, but always by shearing or tension. It is, of course, obvious that the vertical joints of a brickwork structure must always be points of weakness, as the cement does not set under conditions favorable to securing a good hold on the bricks, as in the bed joints, and in the piers in question failure always commenced at one of these vertical joints. In concrete, on the other hand, no such planes of weakness exist, whilst even in brickwork the conditions may be such as to prohibit failure from this cause. Still, experiments made in Austria on a brick arch of 75.5 feet span, having a rise of one-fifth and a thickness of 1.97 feet at crown and 3.6 feet at springings, resulted in its giving way when loaded on one-half the span with a load of about 27 tons per square foot. The dead weight of the arch itself must have given a stress of about 3.3 tons per square foot at the crown, which the test load would have increased to 6½ tons. In addition to this, the bending moment at the abutment, due to the unsymmetrical distribution of the test load, would, on the ordinary theory, have given rise to a stress of about 11 tons per square foot, thus making a total stress of some 14 tons per square foot on the most severely strained material at that point. In other parts of the arch—say, at a point about one-fifth the span from the crown—the calculated stress must have exceeded some 19 tons per square foot. Cracks were produced when the calculated tensile stress at the points of rupture reached from 3¾ to 5½ tons per square foot." An account of a discussion of Prof. Unwin's report is given in *The Journal of the Royal Institute of British Architects* (Dec. 31).

Electric Furnaces.

WHILE not believing that, where coal is employed for driving dynamos, the electric furnace can generally compete with furnaces directly heated by the combustion of coal, coke, or fuel gas, and, while admitting that producer gas, semi-water gas and water gas itself, have many advantages in common with electric furnaces for special heating where it is desirable to exclude dirt and other impurities from crucibles, Mr. F. H. Leeds, in *The Electrician* (Jan. 22), maintains that the electric furnace is economically comparable with fuel-heated furnaces, wherever cheap water power can be obtained. When the cleanliness, convenience, and ease of regulation of electric furnaces are taken into full consideration, it will be found that the electrical furnace has a future and a field in which it can compete directly with coal, even when the latter seems to occupy a perfectly unassailable position. It is because of the capacity to yield—so to speak—"pure unadulterated heat" that such a future may confidently be predicted for the electric furnace. There are many cases in mechanical construction, and in laboratory work, wherein the power to heat, while excluding air, oxygen, and other substances, is so invaluable that the smaller cost of fuel-heating is not worth a moment's consideration.

The Bertrand-Thiel Process.

THIS process, as studied *in situ* by Mr. Percy C. Gilchrist, is described by him in a paper read before the Middlesborough meeting (Dec. 14) of the Cleveland (Eng.) Institute of Engineers. From an advance proof of this paper, we are able here to set forth the main features of the process and some of its results. Descriptions of the process were given in a paper presented at the Colorado meeting of the American Institute of Mining Engineers (September, 1896), and in *The Iron and Coal Trades Review* (Oct. 27, 1896). The observations and conclusions of an expert eye-witness are of additional interest. The process is as follows:

A furnace having power to melt wrought iron, if that should be necessary, is employed. In one of the charges described in the paper the metal discharged from this primary furnace was hot enough to freely volatilize. Brown smoke rose from the metal, as it ran down the landers, and this metallic vapor oxidized as soon as formed in the way that it does in the afterblast in the basic bessemer process, or in the acid process when a sufficient quantity of silicon is present. The work is divided between two, or a series of, furnaces. "Not less than three furnaces should be employed; two to superheat, desiliconize, partially dephosphorize, and decarbonize." Mr. Gilchrist thinks that "possibly six furnaces would be best, four to superheat molten metal from the blast furnace, one to desiliconize and dephosphorize to 0.10 per cent.," and one to still further desiliconize and dephosphorize to 0.01 per cent. These would be called "primary, secondary, and finishing furnaces," the metal issuing from the latter being ready for a casting. But he further says that good work is being done with only one primary and one finishing furnace. At Kladno, where the process was studied, the latter arrangement of furnaces is employed, but Mr. Gilchrist thinks that two primary furnaces and one finishing furnace would be a decided improvement. In such a case the metal from the primary furnaces would pass to the finishing furnace, which removes the remaining phosphorus and carbon, and the slag would be received by a bogey. When only two furnaces are used, "the ore and lime are added in the primary furnace with the charge (in the middle); in the finishing furnace, some ore and limestone are added with the charge (in the middle), the balance of ore and lime, if necessary, being added just before this furnace receives the metal from the primary furnace." Plans of this and of the series arrangement are presented with the paper, and a mass of tabulated data is supplied. A record of materials charged and products obtained in four separate charges is also given, together with details of times and manner of charging, very much too voluminous for reproduction here. The entire paper must be consulted for these particulars. An important deduction from these observations is the opinion that, if such a furnace as the primary furnace of the Bertrand-Thiel process "were employed as a feeder to the basic bessemer converter, no afterblow would be required." The metal from this primary furnace must be hot enough for treatment in the basic converter, since it emits copious vapors of iron. "If such a furnace be employed as a feeder to a second Siemens furnace, then this furnace would in less than one hour be ready for casting steel with traces of phosphorus and with any desired carbon whatever." The author also declares his opinion that a "commercial pig and ore direct process" is now available to the steel trade. The quality of the product is declared to be "equal to Swedish from any non-sulphurous pig"; a yield hither to unapproached is attained,and speed of working per furnace is increased. These statements come from an authoritative source, and lead to the belief that the Bertrand-Thiel process is destined to a future rivaling in usefulness other famous processes that have preceded it.

Balanced Slide-Valves for Locomotives.

WE have before noticed the present leaning toward features of American practice manifest in British railway engineering and management. There may well be reasons for some existing differences, but it cannot be that some things which have found favor among railway men in the United States and have there proved their value would not also be found serviceable on English railroads, notwithstanding that they have been, until recently, persistently ignored by our British cousins. Among the valued things pertaining to North American railroading is the balanced slide-valve, that form known as Richardson's having been fitted to a large number of locomotives, and used with good results. Speaking of this fact, *The Engineer* (Jan. 22) attempts to find a reason or reasons why the balanced slide-valve has found so little favor in England, and, after a review of the present status, in which the desirability of balancing is frankly conceded, recommends a reconsideration of the whole question. "The special feature of the English engine—inside cylinders—

places particular difficulties in the way. With seventeen-inch cylinders there is no room to spare for balancing devices, if the valve chest is placed between the cylinders. In the United States the inside-cylinder engine is unknown, and the valve chest on the top of an outside cylinder permits any balancing device to be adopted which is less high than the top of the chimney. In England, however, of late, the increase of pressure has once more directed attention to balancing, and we have piston valves under trial on more than one railroad." The Richardson valve is well spoken of ; reasons are assigned why it has not succeeded in English practice, these reasons having been derived from an American source, but being seemingly approved as valid by our contemporary, which says : "We have been told by a competent United States engineer that we have failed in this country, because our workmanship has been too good ; the rings have been fitted too tightly in the groove ; but, besides this, English engineers have universally, or nearly so, used circular rings, whereas the Richardson valve is fitted with straight, separate, packing strips, which are a loose fit, and are made tight by the side pressure of the steam in the grooves. The success which has attended the use of the Richardson valve seems to substantiate the American argument, and justify the method of construction adopted. We have not summed up all the objections to balancing, when we have said that relief rings have not been successful. What will do very well in an engine which never runs many strokes without steam will not necessarily prove suitable to an engine which may have to make many hundreds of revolutions without steam. Unless some form of relief valve is fitted to the cylinders, a locomotive with balanced valves will, when running down an incline, draw in cinders from the smokebox through the exhaust. The absence of such relief valves has more than once caused disaster. Their introduction, no doubt, increases complication. It might be possible to get over the difficulty by so coupling up the handle of the regulator with the cylinder drain-cocks that it would be impossible to close the regulator without opening the drain-cock, while those in turn could be opened by the driver when steam is on. Very little ingenuity would suffice for this. Possibly the drain cocks would have to be made a little larger than usual. But, after all, the introduction of a special relief-valve does not seem to be a very great evil. Such valves have been used on the Northeastern, the Midland, the Caledonian, and some other lines, without any particular trouble."

Sulphate of Ammonia.

ONE of the important by-products of the manufacture of gas is sulphate of ammonia. This is the most concentrated plant-food yet artificially produced, adding annually a large increase to the productiveness of the soil, and adding also to the revenues of the various gas undertakings throughout the world. Formerly the reputation of this fertilizer suffered from its imperfect manufacture. It affected crops very much as animals would be affected by a supply of poisoned food. In fact, it *was* in many instances *poisoned* plant-food. Now, it is, or can be, supplied free from the injurious substances that once contaminated it, and, as so supplied, it is claimed by Prof. H. H. Cousins of the South-Eastern Agricultural College, Wye, England (*Journal of Gas Lighting*, Jan. 26), it is the cheapest and most economical manure for furnishing nitrogen to plant growth. In view of the growing importance of this manufacture (it has increased in England since 1870 from 40,000 to upwards of 160,000 tons), Prof. Cousins commences, in the above-named issue of *The Journal of Gas Lighting*, an essay upon the subject, which will be printed serially. The first part deals with sources of supply, the injurious impurities still to be found in some samples of the salt, and of a ready means whereby almost any one can determine the quality of the commercial article. The chief impurities to be guarded against are the sulphocyanids and an excess of acid. Sixteen per cent. of free acid has been found in some of the English samples, and two per cent. is sufficient to render it destructively injurious when applied to crops. The sulpho-cyanids should be completely removed, eight pounds per acre of this impurity being enough to destroy a growing crop, as asserted by the late Dr. Voelcker. Prof. Cousins therefore holds that the reputation and future sale of this salt must depend upon its sound manufacture, its purity, and its fertilizing value. The chemically pure salt should contain 25¾ per cent. of ammonia; the ordinary commercial product should contain from 24 to 24½ per cent. For fertilizing purposes, if the salt be free from the positively hurtful substances above named, it need not be pure. It may be tested as follows: "If heated to redness, it should volatilize completely. Adulteration with sand may be thus readily detected. To test for the presence of sulpho-cyanids, dissolve a dessert-spoonful of the salt in a little warm water, and add a few drops of the solution of chlorid of iron. Any red coloration is proof of the presence of poisonous sulpho-cyanids; and the sample is consequently dangerous to the health of plants. The remarkable variations in the color of the commercial article are due to slight traces of tarry matter, or to the quality of the acid employed in the manufacture. Vitriol derived from pyrites contains arsenic, and a yellow tint (due to sulphid of arsenic) is often observed in sulphate made from such acids. Blue or violet tints are due to traces of dyes produced from the tar products present."

Have We a Correct Theory of the Steam Engine?

NOTWITHSTANDING the facts that the world has been revolutionized by steam, that the ablest minds of the century have devoted themselves to investigating its properties, its behavior in steam engines, and the principles of heat engines, and that the conversion of heat into work is a process as familiar to most people as the cooking of food, some one occasionally springs upon us a new theory, or regales us with an account of experiments which completely unsettle our cherished convictions, and leave us in a state of mental confusion. We feel after something of this sort, much like the Frenchman who, after imbibing freely a particularly good vintage of Schloss Johannisberger, "did not know vere he vas any more." It is like getting up suddenly from a long-occupied stooping position, to rise from the persual of an editorial, "Expansion v. Throttling," in *The Engineer* (Jan. 22), and of the series of articles begun in the same issue, to which this editorial refers. It gives one, figuratively speaking, a rush of blood to the head. One feels like leaning up against something to think, like Mark Twain's fiery Arabian steed. The series of articles named illustrate and describe the experimental engines at the Durham College of Science, at Newcastle-upon-Tyne, England, with some results from the same. The first part describes the engines and their accessories; the second deals with the vertigo-producing results obtained by these remarkable machines. We opine that most people who have made steam a study will desire to correct their misapprehension by a persual of these articles. Next to knowing a great deal is it useful to know the limitations of our supposed knowledge. We begin to think, after reading the editorial in *The Engineer*, that these limitations are much greater than is generally supposed, and that neither it, we, or any one else knows anything about steam worth speaking of, not excluding even Prof. R. L. Weighton, M. A., vice-president, who contributes the article describing the Durham College Engines. Let the editorial speak for itself: "Professor Weighton is far too able and experienced an engineer to attempt to do more than one thing at a time. He impresses the lesson, indeed, so often forgotten, that, if more than one factor is varied, in any experiment, it is impossible to connect cause and effect in analyzing results. It is because this great truth is overlooked, disregarded, or undervalued that so many experiments with machinery of all kinds have been rendered abortive. But Prof. Weighton does not rest satisfied with calling attention to this truth. He goes on to say that the results of several individual trials are often found to be inconsistent and sometimes even contradictory.

We think that Prof. Weighton might have dwelt to advantage on this point. We have indirectly and directly insisted on it over and over again. We have felt that the paramount difficulty in the way of reformation of a theory of the steam engine lies in the contradictory results of experiments. Half a dozen theories have been prepared and put before the world as satisfactory explanations of all that does —and, we may add, does not—take place in a boiler, steam-pipe, cylinder, and condenser of a steam engine, and not one of these theories will satisfy all the conditions, or all the phenomena which are presented to the engineer or the physicist; and we find that what has apparently been proved up to the hilt by one set of experiments is equally proved not to be true by another set." It is asserted that Prof. Weighton's experiments are "no exception to the general rule."

This kind of thing makes one's head swim. But when this kind of thing is followed up by assertions that Prof. Weighton's experimental engines gave a difference of water-consumption of less than two pounds for expansions respectively of 17.4 times and 69.7 times; that, with the same ratios of expansion, different experiments gave notably different results; that in one case a notably better result was obtained by throttling to an average pressure than by an expansion of 19.8 times, and many more similarly puzzling results; when we read the deduction that these results indicate that "steam engines should be made as small as possible for their power,"—we begin to lose our faith in a supreme ruling power, to wonder what manner of machines Prof. Weighton has thus invented for the manufacture of riddles, and to marvel less at the work of that great genius, Grant Brambel, who has made a rotary engine of 300 h. p. to occupy a space of only 6″ × 18″, and proved its inestimable value by getting the assertion printed that he had sold the patents, with some important reservations, for some seven millions of dollars. In the practice of steam engineering we do not know where we are any more.

THE FRENCH AND GERMAN PRESS

The "Regulation" of the Iron Gates.

THE completion of the improvement works at the Iron Gates of the Danube, an undertaking begun by the Romans more than two thousand years ago and continued at irregular intervals ever since, marks an important engineering and commercial achievement. The *Zeitschrift d. Oesterr. Ing. u. Arch. Vereines*, in reviewing the valuable descriptive book of Béla v. Gonda, the Hungarian director of internal navigation, gives an excellent account of the work accomplished, and from this we make some extracts.

The principal point to be accomplished by the "regulation" of the river was the production of an unobstructed water-way from the city of Orsova through the rocky shallows of the Iron Gates and through the cataracts and whirlpools below, to the clear channel beyond, thus connecting the enormous traffic of the Danube, the great natural highway for the commerce of eastern Europe, with the outlet to the Black sea.

The general plan adopted consisted in the construction of a series of canals close to the right bank of the river, the canals enclosing a portion of the stream and providing an artificial channel. The rapid and irregular drop of the Danube has thus been converted into a gradual slope in the canals, so that the stream has practically been "graded" through the obstructions. It was decided that this channel should be not less than 60 meters wide, and should provide a depth at least 2 meters greater than the greatest recorded depth at Orsova,—the so-called "Orsovaer Pegel."

The actual work was commenced in the autumn of 1890, operations being started at the fourth cataract below the Iron Gates, the "Jucz-Katarakt"; here a canal 3,500 meters long was cut through the hard rock, enabling small boats at once to work their way up from Drenkova to Orsova. At the third cataract, called "Izlas-Tachtalia," the obstructions consisted of numerous groups of rocks, among which the water rushed in many leaps and eddies; here, owing to the rapid fall, a massive stone dam was necessary. This dam extends downwards diagonally across the river, being 6,200 meters long, and contains 500,000 cubic meters of rip-rap. At this cataract the river was formerly so shallow that navigation was utterly impracticable at low water for anything but rafts. The construction of this dam was, next to the blasting of the channel through the Iron Gates, the greatest work in the whole undertaking. The section of the canal at this point is 3,900 meters long.

The second cataract, "Kozla Dojke," is about five and a half miles farther up the river, and is passed by a canal enclosed between masonry walls for a length of 3,500 meters, while at the first cataract, just below the Iron Gates, there are 2,700 meters of canal to convert the very rapid fall of the stream into a navigable channel.

The Iron Gates themselves consist of five rocky dykes, extending across the river and reaching nearly to the surface of the water, the whole forming a sort of submarine plateau more than a mile in length, and over this natural dam the water rushes with great velocity. Some attempts were made to blast a channel through at this point in 1847-49, but a depth of only about four feet was secured. Since the peace of Paris in 1856, and especially since the Berlin congress in 1878, by which the international commissions were intrusted with the control of the river, and war-ships forbidden in the stream below the Iron Gates, the united interests of Austro-Hungary, Servia, and Roumania have urged the full completion of the channel, and this much-desired result has now been accomplished. Partly by damming the river, but largely by submarine blasting, the last canal has been cut through this series of natural obstructions, its length being 2,200 meters, width 60 meters, and depth full 3 meters.

This means that vessels of 2,500 tons displacement, and more than 8 feet of draft, can pass all the way up from the Black sea, past the four cataracts and through the Iron Gates, to the docks at Orsova.

Since the completion of the work, the passage up the stream through the canals has been made by unloaded tug-boats at the rate of 3¼ miles per hour, or, with heavy tows behind them, at a rate of more than half a mile per hour.

The formal opening of the canal by the emperor of Austria and king of Hungary, with the kings of Servia and Roumania, on September 27, 1896, was the great event of the Hungarian Millennial Celebration. The total cost of the present works, from 1890 to 1896, was 18,625,000 florins, or about $8,750,000.

The Sewage Plant at Budapest.

SINCE 1891 the city of Budapest has had under construction an important sewage-pumping plant, and the current number of the *Zeitschrift des Vereines Deutscher Ingenieure* contains a fully illustrated article describing the pumping machinery. The conditions of the problem were sufficiently varied to require an elastic plant, so to speak. When the level of the Danube is low, the sewage can be drained into the river by gravity, but for mean and high water pumping becomes necessary. At the same time it is required that the sewage shall be delivered at will to certain sewage farms nearly two miles distant, this latter duty involving an elevation of the liquid against the head of 16 meters. The ordinary service of the pumps, as demanded by the specifications, is the delivery of 1.8 cubic meters per second against a head of 5 meters; but, when the sewers are to be kept clear of storm water, the capacity is given as 27 cubic meters per second against a head of 1.55 meters.

In order to meet these varied requirements, the plant, as designed by Engineer Mich. v. Kájilinger, is divided into two distinct parts. One portion consists of six direct-connected centrifugal pumping engines, and the other of five horizontal plunger pumps, the former delivering only against the low head into the Danube, and the latter forcing against the high-pressure delivery to the sewage farms.

The centrifugal pumps are arranged in pairs, each pair being driven by a vertical compound engine placed between them. One pump is keyed fast to the shaft, and the other is connected by a Mechwart friction clutch, by which it can readily be thrown in or out of service. The diameter of the pump fans is 71 inches, and the engine cylinders are 15 inches and 23 inches in diameter, respectively, with a stroke of 21 inches, the speed ranging from 80 to 160 revolutions per minute, according to the requirements, and the boiler pressure being 110 pounds. The maximum capacity of each of the centrifugal pumps is 2.25 cubic meters per second, and, as each of the six engines drives two pumps, the maximum capacity of the plant for the low lift is 27 cubic meters, as required.

Some of the details of these engines are of interest, although in the main they do not show wide departures from general practice. The high-pressure cylinder is fitted with a Rider cut-off valve controlled by a Porter governor and dashpot, while the low-pressure cylinder has a slide-valve of the Trick or Allen type, neither valve being balanced. A special feature of the governor is the device by means of which the speed of the engines may be altered and controlled. The dashpot connected with the governor is supplied with oil at a constant pressure from a small pump, operated by an eccentric on the governor spindle. This oil flows through the dashpot cylinder at a rate controlled by an opening in a passage in the side, and returns to the pump again. By varying the size of this relief opening the pressure upon the dashpot piston is altered, which is equivalent to changing the weight on the governor, so that the speed of the engines can be changed at will from 80 to 160 revolutions, in order to meet the emergencies which may arise.

Tests of the engines and pumps showed a performance of about 35 pounds of steam per horse power of gross work in the form of sewage raised,—this including all steam used for boiler feed and for condensing water. The efficiency, as shown by indicator cards, appears to have been about 17 to 18 pounds of steam per indicated horse power.

The high-pressure pumping engines consist each of a cross-compound Corliss engine, with cylinders 24.8 inches and 37.8 inches in diameter and a stroke of 47.4 inches, the piston rod of each cylinder being prolonged through the back cylinder head to form the pump rod. These engines are intended to run at a uniform speed of about twenty revolutions per minute, as they do not have to deal with the emergency flow.

The sewer system delivers into a large collecting sewer, which is situated at so high a level as to discharge into the river by gravity; and this collector is provided with ample overflow openings into a low-level collector leading to the pumps, which are thus called into use whenever the gravity discharge is impeded by high water. An independent feed collector leads to the high-service pumps, so that the sewage-farm supply is always provided for.

The Right of Employers to the Inventions of Employees.

THE question as to the ownership of inventions made by those who, at the time of invention, are in the employ of others is one upon which there has been some discussion in this country, although of late it has generally been settled by special contract made at the time of engagement.

An interesting article in *Glaser's Annalen* for January 15, by Dr. Jul. Lubszynski, discusses the status of the question in Germany, and we abstract from this his leading points.

The present patent law of Germany does not provide for the question, but the Austrian law states that workmen, employees, or government servants have the right to the inventions which they may make, unless there is a specific written contract to the contrary; and that rules of employment intended to take this right from the employee shall be void in law.

In practice, however, this law has not been found to cover all the conditions. In many cases a man is employed for the very purpose of developing and improving an appliance, and a contract in such a case should clearly not be necessary to secure to the employer the right to the product of his employee.

Again, the Austrian law makes no distinction between inventions made during the working-hours of the employer and those made in the private time of the employee. Upon this point there has been much discussion, and in Prussia there has been an attempt to give—for public work at least—a claim to the employer upon inventions pertaining to the work involved. As the law in Austria now stands, the employer has not even a shop right in inventions made during working-hours upon the special line of work in which the employee may be engaged.

In the line of suggestions for a proposed German enactment Dr. Lubszynski notes that there should be, if possible, some limit as to the nature of the invention, although he admits that it is not always easy to determine whether or no an invention comes within the special line of work in which the employee is regularly engaged. There should be also some consideration of the special circumstances in which the invention is made.

The precise moment at which an invention is made is not a matter which can be exactly determined. A man may conceive an idea outside of working-hours which clearly would never have occurred to him had he not been engaged upon the duties of the day, or, again, he may be engaged during his evening hours upon a totally different line of investigation, using his own materials and bearing all the expense himself, and yet make an important invention in that line during his employer's time. All these conditions should properly be taken into account in framing a law which shall be just to both parties alike, and, while the employee should not be deprived of the title to his invention, yet in many instances a limited right to the use of the invention should remain with the employer.

Proposed Electric Tramways in Paris.

The question of increased facilities for local transportation in Paris is being agitated, especially in view of the anticipated requirements for the coming exposition, and *La Révue Technique*, for December 25, contains an outline of the scheme of MM. Cauderay and Renard for a system of electric tramways which shall meet all the demands of the situation. Apart from the local features of interest which the plans present, it is worthy of note that the scheme includes the idea of combining both underground and overhead trolleys with a storage system. Each car is to carry a storage battery, which may be charged at any time when in connection with a trolley wire, and the current from the storage battery is to be used to carry the car over that portion of the city in which no wire, either overhead or underground, is permitted. Wherever a subterranean conduit is permissible, it is to be constructed, while in the suburbs the overhead wire is contemplated. The practicability of the combination scheme is yet to be determined, but it is possible that in some such method the problem may be solved with justice to all concerned, not only in Paris, but on this side of the Atlantic as well.

The Le Chatelier Pyrometer.

The difficulties in the way of the precise determination of high temperatures are well known, and, although the air thermometer has solved the problem for the most refined investigations, it is of necessity a laboratory instrument, unsuited for every-day use in manufacturing establishments.

The thermo-electric pyrometer of Le Chatelier, in its latest improved form, seems, however, to give greater promise of useful application than any other instrument yet devised for the purpose, and the following description of the apparatus is condensed from an article by Dr. Russner in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for January 1.

Heretofore the fact that an electric current is developed when the junction of two dissimilar metals is warmed has been applied to the indication of very slight differences of temperature, as in the well-known thermo-electric plie. In the Le Chatelier pyrometer, however, the principle is modified by using two metals so nearly alike that a high temperature is needed to produce a moderate electromotive force. Briefly, the element consists of two wires, one of platinum and the other of an alloy of platinum and rhodium, each wire being about one meter long, and the two being fused together at one end. One of the wires is inserted in a porcelain tube open at both ends; the other is carried along just outside, so that the junction of the wires is at the end of the tube. This tube is then slipped into another tube, also of porcelain, but closed at one end, the junction of the wires being in the closed end, and the two free ends of the wires brought out to connections to a galvanometer.

The whole is enclosed in a protecting tube, open at the end, which is inserted into the furnace whose temperature is to be determined. Since both platinum and the platinum-rhodium alloy have very high fusing-points, the portion of the instrument which is exposed to the heat is able to stand very high temperatures, while the galvanometer upon which the readings are made may be at any distance from the furnace, either in the office or in any desired part of the establishment.

Each pyrometer is calibrated by comparison with an air thermometer, and it has been found that an alloy of 90 per cent. platinum and 10 per cent. rhodium for one wire, and pure platinum for the other, give an electromotive force nearly proportional to the temperature, so that a temperature of 1,800 degrees C. produces 1,800 microvolts, etc. This is almost exactly true for temperatures of 700° C. and above. An alloy of 85 per cent. platinum and 15 per cent. rhodium produces a feebler current, an electromotive force of 800 microvolts being produced by a temperature of about 1,650° C.

The principal difficulty seems to consist in the production of a definite alloy of platinum and rhodium, on account of the high fusing-point, but the firm of Heräus at Hanau a. Main has now put on the market platinum wire containing 10 per cent. of rhodium, well adapted for this use. Although any galvanometer may be adapted for use with this form of pyrometer, a special instrument on the Deprez-d'Arsonval principle is furnished by the makers of the pyrometer, Messrs. Keiser & Schmidt of Berlin, the whole design of the apparatus having been made by Dr. Holborn and Dr. Wien.

Experimental comparisons with the air thermometer have shown that the Le Chatelier pyrometer will determine temperatures within an error of ± 5° C. for 1,000°. One of the instruments was subjected to the continuous action of a Siemens regenerative furnace in a glass-works for 3½ months without injury, following the variations of temperature between 1,100° and 1,600° C.; when re-compared with the air thermometer, the zero was found to be unchanged.

In this connection the following determinations of fusing-points made by the Le Chatelier pyrometer and those of previous observers are given, those of Holborn and Wien having been made with the new pyrometer.

	Violle.	Barus.	Holborn & Wien.
Silver	954°C	986°C	971°C
Gold	1,045°	1,091°	1,072°
Copper	1,054°	1,096°	1,082°
Nickel	———	1,476°	1,484°
Palladium	1,500°	1,585°	1,587°
Platinum	1,775°	1,757°	1,780°

The Senegal-Niger Railway.

THE return of the Hourst Niger expedition, and the account of its successful navigation down the Niger from Timbuktu to its mouth, give added interest to the description of the Senegal-Niger Railway in the *Revue du Génie Militaire*.

The Senegal river flows into the Atlantic at the extreme western point of Africa, passing through the French colony of Senegal, the town of St. Louis being at its mouth. The river is navigable as far up as Kayes, about four hundred miles from the coast; while about one hundred miles further back it divides into its two sources, the Bahfing and the Bakhoy, which originate in the mountains of the Soudan.

The Niger has its rise in the same mountains, but, instead of flowing westward, it takes the other side of the watershed, and, after traversing about seven hundred and fifty miles of territory to the north-east, it turns southward and empties into the Gulf of Guinea.

The plateau, which is reached by the navigable waters of both rivers, is less than three thousand feet above sea-level, and for many years the idea, which originated with General Faidherbe, of connecting the upper portion of the two rivers by a railroad has been a favorite one with the French government.

A portion of the road has now been built, and the account of the work and its difficulties is especially interesting at the present time. In the preliminary operations there were many set-backs, due to unfavorable weather, sickness, and other delays, but by 1888 more than eighty miles, from Kayes to Bafoulabé, had been constructed after a fashion, including the viaduct bridge at Galougo.

Much of this work, however, was imperfect, being ballasted only where local rock was available, and in the rainy season many washouts occurred. In 1892 the work was turned over to a detachment of French army engineers, and the road has been actively pushed since that time. The old work has been reballasted and repaired, and the extension of the line toward Bammako on the Niger has been surveyed and partially constructed. While about two-thirds of the road remains to be built, there is every reason to believe that its completion will be rapidly pushed through, and the fact that the portion already built is nearly paying its operating expenses is in itself most encouraging.

The completion of the line will open a commercial route through the richest portion of western Africa, the combined length of the railroad and waterways being nearly two thousand miles, giving access to the city of Timbuktu and complete internal connection from the west coast to the Gulf of Guinea. At the present time there is telegraph communication from Kayes to St. Louis at the mouth of the Senegal, and a cable from St. Louis to

Europe by way of Teneriffe, so that this line places the heart of western Africa in direct communication with the civilized world.

When it is considered that this railroad has been planned and already partly constructed through a country in large part unknown and only partially subdued, and that the difficulties of an insalubrious climate and native opposition have been successfully overcome, we cannot but admire the energy and persistence of Messrs. Marmier and Joffre, the engineers by whom the plans of General Faidherbe have thus far been realized.

The Sanitation of Steamships.

A VERY valuable series of articles by Herr Carl Busley is appearing in the *Zeitschrift des Vereines Deutscher Ingenieure* upon the sanitary arrangements of modern steam vessels, and the high reputation and wide experience of the author render his opinions important.

Beginning with the subject of fresh air, the various systems of ventilation are described, with plans of the arrangements of windsails, air ducts, exhausters, fans, and the like, details of the various methods being given. In some cases forced ventilation is used, and in others only exhaust fans are employed, but Herr Busley prefers a combination of the two, the fresh air being delivered under pressure to the lowest and most distant points of the vessel, while the foul air is drawn off above. The system, as applied to the German cruiser, "Aegir," is shown as an example of this double system.

The question of drinking water is next taken up, and the various forms of filters, distilling apparatus, etc., are illustrated and described. With these are also given the arrangements for the supply of hot and cold water to the innumerable washstands, as well as the bath-rooms; and, although the especial plans shown are those of a modern ship of war, yet the details are practically those adapted for passenger-steamers as well, many of them being those used by the vessels of the North German Lloyd Company. The question of the discharge of waste water and the arrangement of water-closets is given space in proportion to the importance of the subject, and articles on lighting and warming will follow.

While these matters are even more important on shipboard than ashore, they have been given little or no consideration in the treatises on ship construction, and, from the nature of the case, methods which are satisfactory in hotels and residences cannot always be used on a great vessel; hence these articles by the director of the great yard at Kiel are a welcome addition to marine literature.

The Danube-Moldau-Elbe Canal.

THE project of a canal to unite the navigation of the Danube with that of the Elbe through the Moldau has been a subject of many plans and discussions, in times past, but it now bids fair to become a reality, judging from the plan of the Austrian government, described in the January issue of the *Oesterr. Monastchr. f. d. oeffent. Baudienst.*

The first official action leading to the present scheme was the appointment in 1879 of a commission, which investigated the problem at length and reported in the spring of 1884 upon the feasibility of the work, as well as upon the concurrence of Bohemia in the political questions involved.

This was followed by a competition for the best plan for the execution of the work, including the selection of route and provision for overcoming the differences of elevation and other engineering problems. The commission having charge of the competition issued, in May, 1892, the conditions within which the plans were to be prepared, and the result has been the submission of three schemes, by as many different engineering firms.

It is contemplated to build the canal from the Danube, at or near Vienna, to Budweis on the Moldau, the latter river giving navigable connection with the Elbe and the North sea. This gives a length of from 100 to 125 miles, depending upon the choice of route, while the difference in elevation between Vienna and Budweis is more than 600 feet, with an intervening elevation of about 1,200 feet to be surmounted. The canal is required to be 98 feet wide at the surface and 60 feet at the bottom, the depth to be about 7 feet, with provision on all bridges for deepening to 8 feet, the canal being intended to receive vessels of 200 feet in length and 25 feet in breadth, at the water line, with a draft of 5 feet 9 inches.

The work also includes the "canalization" of the Moldau from Budweis, and the Elbe from Melnik, so as to provide a channel of a minimum depth of 7 feet, with locks arranged to permit continuous navigation, and weirs to provide for the passage of rafts.

The minimum width of any tunnel is to be 35 feet, with a headway of 20 feet above the surface of the water.

The plans submitted follow different routes, and the methods by which the different engineers propose to solve the difficult problems involved are of interest.

The firm of Hallier & Dietz-Monin proposes to overcome the height of nearly 1,250 feet which their route involves, by means of seven inclined planes with slopes of 40 to 60 per cent. This plan involves a canal 181 kilometers long and a cost of $30,000,000, or about $273,000 per mile.

The second plan—that of Herr Gröger—is somewhat shorter, as it leaves the Danube about 50 kilometers above Vienna. It involves the use of a combined system of locks and inclined planes, the estimated cost being about $26,000,000,—about the same per mile as that contemplated by the previous plan. This scheme includes two tunnels 6,000 and 8,000 feet long, respectively.

The third plan—that of the firm of Lanna & Vering—offers a lock system, and includes one tunnel of 6,000 feet in length and five smaller ones of 300 to 3,000 feet. This canal would be 130 miles in length, and the estimated cost is $28,000,000, or about $215,000 per mile.

All of these plans include elaborate systems of reservoirs for the supply of water, it being estimated that a storage supply of about 25,000,000 cubic meters will be required.

Taking into account the cost of improving the rivers, it is estimated that the entire cost of a water communication between Vienna and the North sea will be about $47,000,000.

The manner in which this sum is to be raised does not yet appear, but it is intimated that the project should take on the character of an international work, constructed and maintained by Austria, Prussia, Bohemia, Saxony, and, indeed, the "united States of Europe."

Carbons for Electrolysis.

THE extension of electrolytic processes in industrial chemistry has created a demand for terminals which shall be inexpensive and permanent, and numerous patents in this line have been taken out, especially in connection with the electrolytic production of the alkaline chlorids.

Dr. Albert Lessing describes, in the *Elektrochemische Zeitschrift*, some of the objections to those in use, and claims to have overcome the difficulties. The ideal anode should possess the qualities of permanence, small volume, and moderate expense. The first two properties are possessed by platinum, but its high cost is prohibitive for use in large operations, such as commercial reasons demand. Carbon has been used as the most available material, but in its present forms is not free from objection.

Gas carbon is not available in large sheets, such as are commercially required, and hence these have been made of powdered coke, baked with a cementing material in the same manner as electric-light carbons are made. Such carbon plates, however, are not permanent, but soon become disintegrated by the action of the solutions, and especially by the action of the liberated gases. This disintegration is rather a mechanical than a chemical action, and the slightest porosity or the finest crack gives the gases a chance to enter, after which the carbon flakes off in layers and crumbles away, fouling the bath and interfering with the work.

Dr. Lessing claims now to have solved the problem, after much experimenting, by producing carbon sheets entirely homogeneous and free from cracks, by a fusing process which not only insures the permanence of the sheet, but also increases its conductivity. The new product is said to be harder than steel, readily scratching glass and proof against the emery wheel, and possesses a metallic ring which testifies to its homogeneity. If these claims are maintained, and the prepared carbon can be produced at a reasonable price, it should soon be on the market for many other uses as well as the one for which it was originally produced.

Electric Traction in Germany.

ELECTRIC tramways are making rapid progress in Germany, and a review of recent installations is given by Ober-Ingenieur von Krenn in the January issue of the *Oesterr. Monatschrift f. d. Oeffentlichen Baudienst.*

The overhead trolley is making its way rapidly, and is now in use not only in Remschied, Barmen, Hanover, and Hamburg, but also in Dresden, Leipzig, and Berlin. In the central portion of Dresden, however, the unsightly trolley wire has not yet been admitted, and the combination of overhead wire and storage-battery is used, the batteries being used for motive power in the section where no wires are permitted.

In Berlin two underground installations are being constructed, one by Siemens & Halske, and the other by the Union Elektricitäts Gesellschaft, and it is understood that several overhead systems are to be replaced by underground conductors.

The speeds in use are about the same as those in this country, the limit in Dresden being eighteen kilometers an hour. Trailer cars are in general use, although most of them have no provision for lighting or braking. In Berlin speeds of fifteen miles are permitted, and in other cities the speeds are regulated according to the part of the city traversed. The smoking-car problem is solved by limiting smokers to the trailers. Germany, like France, seems to be endeavoring to obtain the advantages of electric traction without unnecessary unsightliness, while, as yet, we have to accept all the ugliness or go without the convenience.

The Scandinavian Exposition.

IN 1866 the first Scandinavian exposition was held at Stockholm, since which time there have been two industrial exhibitions, both held at Copenhagen—one in 1872 and the other in 1888. This year there is to be one again at Stockholm, and it is expected that there will be a most interesting display of the special industries of Norway, Sweden, and Denmark.

Since the exhibition of 1866 the development of the mining and lumbering interests of Sweden has been great. To-day 25,000 men are employed in the lumber trade alone, the exports of unworked timber amounting to $31,000,000, and of worked lumber to $5,400,000 a year, while in 1866 the total lumber trade hardly reached $8,500,000.

In the thirty years the production of iron has quadrupled, and the output of steel has risen from 7,000 tons in 1866 to 170,000 tons per year, while the railway mileage has increased from 930 miles in 1866 to 6,200 at the present time.

In view of these conditions, and other branches of trade showing a like increase, a noteworthy exposition of Swedish industries may be expected.

The Bridge of the Paris Exposition.

THE Pont Alexandre III, to which reference was made last month, has been under discussion by the *Société des Ingénieurs Civils de France*, especially with regard to the obstruction which a bridge built after the adopted design will offer to navigation. The adoption of a single arch brings the headway near the banks too low to permit safe navigation beneath, especially since the bend in the river at the location of the bridge throws the channel close to the right bank.

The following points were made,—that the pier on the right bank should be carried back far enough to conform to the requirements of the commission of 1896, and thus not prevent access to the river bank, and that the arch should be raised sufficiently to give a passage not less than 5 meters high and 60 meters wide at all conditions of the river.

THE ENGINEERING INDEX.

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American Architect, The *w.* $6. Boston.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées. *m.* 31 francs. Paris.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $.4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.*. $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrotechnisches Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.

Engineers' Gazette. *m.* 8s London.
Engineering. *w.* 36s. London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
L'Electricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Le Moniteur Industriel. *w.* 40 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
Mechanical World. *w.* 8s. 8*d.* London.
McClure's Magazine. *m.* $1. New York.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver.
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8s. London.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines. *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

ASYMMETRY in Medieval Italian Churches, Constructive. William H. Goodyear (The subject is confined to the cases of constructed asymmetry in the dimensions of arcades and arches, in oblique horizontal lines and in ground plans. Ill. 7,000 w.) Arch Rec—Jan., March, 1897. Serial, first part. No. 10,634. 30 cts.

CHURCH, Plans for a Greek Catholic—at Sereth (Project für eine griechisch-katholische Kirche in Sereth) (Brief description and four sheets of drawings. 500 w.) Oesterr Monatschr f. d. Oeffent Baudienst—Jan., 1897. No. 10,778. 30 cts.

COTTAGE Architecture, Notes On. Ralph Nevill (Discusses the subject under the heads of accommodation, style, plan and material. 7,000 w.) Jour Roy Inst of Brit Archts—Dec. 31, 1896. No. 10,673. 30 cts.

CORNER HOUSES in Paris. P. Frantz Marcou (A study of these houses, confined to apartment-houses. Interesting because of the advantage of location and designed to show the original work of French architects. Ill. 3,300 w.) Arch Rec—Jan., March, 1897. No. 10,632. 30 cts.

DESIGNING Buildings, The Use of Practical Geometry In. W. R. Corson (A study of diagrams founded on geometrical figures and their use in planning, making reference to their recognized use by the ancients. Ill. 5,000 w.) Builder—Jan., 16, 1897. No. 10,603. 30 cts.

FIREPROOF Flooring, A New System of (Describes the Hallberg system, as reported by the Chicago Record. It proposes the using of suspension rods as carrying members, with tiling and concrete as compressing members. 700 w.) Arch & Build—Jan. 9, 1897. No. 10,332. 15 cts.

FIREPROOF Construction, Some Valuable Opinions (Interviews with the aim of obtaining current opinion in regard to the use and possibilities of terra-cotta. Views of prominent architects of N. Y. and Boston. 3,200 w.) Br Build—Jan., 1897. No. 10,657. 50 cts.

FLOOR Construction in New York City, Fireproof (Presents and discusses facts collected on this subject, and the New York building law. 5,000 w.) Eng News—Feb. 4, 1897. No. 10,902. 15 cts.

FOUNDATIONS, The Distribution of Pressure in Foundations (Ueber die Bedingungen einer gleichformigen Druckvertheilung in den Fundamenten.) A further discussion, by Rudolf Mayer, of the conditions existing between depth, load and cohesion for the uniform distribution of pressure. 3,000 w.) Zeitschr d Oesterr Ing u Arch Vereines—Jan. 15, 1897. No. 10,755. 15 cts.

GOVERNMENT BUILDINGS, The Architecture of Our. William Martin Aiken (An exposition of the duties and methods of the supervising architect of the United States. Ill. 3,100 w.) Eng Mag—Feb., 1897. No. 10,302. 30 cts.

GREAT MALVERN (Illustrated description. 2,200 w.) Builder—Jan. 2, 1897. No. 10,389. 30 cts.

HIGH BUILDINGS Safe, How to Make. Christopher Clarke (Gives the changes that are generally agreed by experts necessary to make them safe. 1,200 w.) Fire & Water—Feb. 6, 1897. No. 10,929. 15 cts.

HOSPITAL. The New Insane Hospital at Münsingen (Canton of Bern). (Der Neubau der Kantonalen Irrenanstalt zu Münsingen (Kanton Bern) (A description with many illustrations, of one of the finest hospitals of the sort in Europe. 10,000 w.) Schweizerische Bauzeitung—Jan. 2, 9 & 16, 1897. No. 10,781. 45 cts.

LINCOLN Cathedral (Illustrated description with history. 2,000 w.) Arch, Lond—Jan. 1, 1897. No. 10,384. 30 cts.

MACHINERY HALL at the Swiss Exposition at Geneva, The (Describes the cantilever system of roof trusses. The plan is chiefly remarkable for its economy in construction and its lightness. 350 w.) Eng News—Jan. 21, 1897. No. 10,556. 15 cts.

MONOLITHIC Churches of Lalibela (Abyssinia), The. From La Nature (Illustrated description of these curious churches. 1,000 w.) Sci Am Sup—Jan. 16, 1897. No. 10,439. 15 cts.

NATIONAL Architecture, Two Interpreters of. Henry Van Brunt (A comparison of the work and career of two eminent architects, John Wellborn Root and Charles Bulfinch, as set forth in recent publications, with much interesting information in relation to American architecture. 7,500 w.) Atlantic M—Feb., 1897. No. 10,577. 35 cts.

PETERBOROUGH Cathedral (Preliminary specification written at the request of the Society of Antiquaries, to explain what would be necessary in works of repair to secure a part of the fabric of the portico from further dilapidation, and to secure its present condition and appearance. 5,700 w.) Arch, Lond—Jan. 15, 1897. No. 10,607. 30 cts.

SANGER Hall, Philadelphia (Illustrated description of the design and construction of a large temporary auditorium. 800 w.) Eng Rec—Jan. 9, 1897. No. 10,336. 15 cts.

SPECIFICATIONS (The first of a series of articles for students giving directions and explaining the object and uses of the document. 2,000 w.) Builder—Jan. 2,

1897. Serial, first part. No. 10,390. 30 cts.

STYLE of Architecture, The Possibility of a New. D. B. Dick (Read before the Ontario Assn. of Archts. An interesting study of style in architecture; the great principles and the elements of architectural construction, and the outlook for future formation of a new style. 8,500 w.) Can Arch—Jan., 1897. No. 10,614. 30 cts.

WALHALLA of Ratisbon, The (Illustrated description of a German Temple of Fame, which is a costly reproduction of the Parthenon at Athens. 600 w.) Sci Am—Jan. 23, 1897. No. 10,535. 15 cts.

HEATING AND VENTILATION.

BOILER Progress. H. J. Barron (Inquiry with view of finding out which is the most practical type for ordinary steam-heating at pressures under fifteen pounds, from the contractor's standpoint. 3,000 w.) Dom Engng—Jan., 1897. No. 10,747. 30 cts.

CENTRAL PLANTS, Warming Office Buildings and Residences from (Notes concerning the design and management of the Harrisburg (Pa.) Steam Heat and Power Co., describing the distribution of steam for the warming of neighboring buildings from a central plant. 1,100 w.) Eng Rec—Jan. 23, 1897. No. 10,600. 15 cts.

DIRECT RADIATION, Methods of Proportioning. R. C. Carpenter (Read at meeting of Am. Soc. of Heat and Ven. Engs. Calls attention to the methods which have been proposed in the past and to a modified method resulting from experiment, which the writer believes to be at least worthy the trial of all heating engineers. 2,500 w.) Met Work—Jan. 30, 1897. No. 10,687. 15 cts.

FAN CAPACITY, Determination of (Explains the method of determining the fan capacity required when the calculations are based merely upon the times of air change; the system generally adopted for factory and similar work. 1,400 w.) Heat & Ven—Jan. 15, 1897. No. 10,517. 15 cts.

FURNACE Heating (Examines the causes why they sometimes fail to heat. 1,200 w.) Dom Engng—Jan., 1897. Serial, first part. No. 10,748. 30 cts.

HEATING and Lighting Plant, An Interesting Central (Illustrated description of the arrangements for heating and lighting a group of buildings at Garden City, Long Island, N. Y. 1,600 w.) Eng Rec—Feb. 6, 1897. No. 10,927. 15 cts.

HEATING AND VENTILATION of Public Buildings, Combined. J. D. Sutcliffe (Read before the Manchester Soc. of Architects. Part first discusses warming by direct and indirect radiation and gives reasons for adopting the warm air system. 3,400 w.) Heat & Ven—Jan. 15, 1897. Serial, first part. No. 10,518. 15 cts.

HEATING AND VENTILATION of the West Side Branch Y. M. C. A. F. R. Harris (Illustrated description. 1,500 w.) Heat & Ven—Jan. 15, 1897. No. 10,516. 15 cts.

HOT WATER Circulation; Fundamental Principles of—on Which the Various Water-Heating Systems Depend for Success. James J. Lawler (The special object is to show these fundamental principles of circulation in a plain, simple way, and lead step by step to the most complicated systems. Ill. 1,600 w.) San Plumb—Jan. 15, 1897. Serial, first part. No. 10,478. 15 cts.

HOT WATER Heating Apparatus, A Novel Steam (The novelty of the system consists in the entire omission of air valves and air-valve piping and also the possibility of controlling the temperature of the coils to suit the weather. Ill. 900 w.) Eng Rec—Jan. 23, 1897. No. 10,601. 15 cts.

HOT WATER Heating Apparatus, Arrangement of Mains in. W. M. Mackay (Read at meeting of Am. Soc. of Heat. & Ven. Engs. Describes earlier systems and gives information from the writer's experience and observation. 2,200 w.) Met Work—Jan. 30, 1897. No. 10,685. 15 cts.

HOT WATER Plant near Philadelphia, A Recent (Illustrated description of the plant in residence of Mr. Cyrus H. K. Curtis, at Wyncote, Pa. 600 w.) Eng Rec—Jan. 9, 1897. No. 10,337. 15 cts.

STEAM HEATING Plants, Defective. W. H. Wakeman (Calls attention to some of the defects that cause a steam plant to work in an unsatisfactory manner. 1,500 w.) Mach—Feb., 1897. No. 10,866. 15 cts.

STEAM PLANT, Boston Public Library and Its. A. J. Guernsey (Brief account of the working equipment, ventilation, lighting, steam plant, boilers, &c. 2,200 w.) Safety V—Jan., 1897. No. 10,489. 15 cts.

VOLUME of Air Passing Through a Register per Minute, Determining the. J. H. Kinealy (Read at meeting of the Am. Soc. of Heat. & Ven. Engs. Gives methods for determining the velocity of the air, tests and results of experiments. 2,400 w.) Met Work—Jan. 30, 1897. No. 10,686. 15 cts.

LANDSCAPE GARDENING.

IMPROVEMENT Societies, Village. Mary Caroline Robbins (Reviews the work and notes what has been accomplished, shows in how many directions the art is being applied, its effect on the value of property and the character of the community. 7,500 w.) Atlantic M—Feb., 1897. No. 10,576. 35 cts.

NORTH WOODS, The (Editorial presenting the importance of New York

State owning this region, with extract from Gov. Black's message. 1,200 w.) Gar and For—Jan. 20, 1897. No. 10,528. 15 cts.

PARK-Making as a National Art. Mary Caroline Robbins (Brief outline of the work in this country, with typical examples of the work and of the artistic skill of Frederick Law Olmsted. The importance and the necessity of proper maintenance, with the unlimited possibilities of the art. 7,000 w.) Atlantic M —Jan., 1897. No. 10,575. 35 cts.

PARK-Making as a National Art (Editorial review of an article by Mrs. M. C. Robbins, published in the Atlantic Monthly for Jan. 1,400 w.) Gar & For—Jan. 13, 1897. No. 10,416. 15 cts.

PLEASURE-GROUNDS, The Need of More Public (Editorial urging that some attention be given to this need of the people, both in city and country. 1,500 w.) Gar & For —Jan. 27, 1897. No. 10,645. 15 cts.

WATERING PLACE, The Springs of Dorna-Watra (Die Curhaus Anlage in Dorna-Watra.) (An illustrated description of the baths and casino at Dorna-Watra, in the Carpathians. 1 plate of architectural plans. 2,500 w.) Zeitschr d Oesterr Ing u Arch Vereines—Jan. 15, 1897. No. 10,754. 15 cts.

PLUMBING AND GAS FITTING.

COMPARISON, A—F. Handover (Views on English and American plumbing. 650 w.) Dom Engng—Jan., 1897. No. 10,745. 30 cts.

GAS CONTROL from Meter to Burner. D. Macfie (A lecture delivered before the District Council for Edinburgh, Scotland, of the National Registration of Plumbers. The need of enlightenment in the proper use of gas. Points where gas fitters could educate their clients. 5,000 w.) Am Gas Lgt Jour—Feb. 8, 1897. No. 10,921. 15 cts.

GILLENDER Building, New York City. Plumbing in the (The peculiarity of dimensions led to unusual features in the disposition of the plumbing, which are herein described. 1,400 w.) Eng Rec—Jan. 16, 1897. No. 10,497. 15 cts.

HIGH-CLASS Plumbing, An Example of (Plans with description of plumbing in the Biltmore and the Blenheim apartment-houses, New York, with specifications. 2,800 w.) Met Work—Jan. 23, 1897. No. 10,570. 15 cts.

MISTAKES in Plumbing Practice, Some Common. W. F. Taaffe (A list of errors which plumbers are liable to fall into and that it would be well to avoid. 1,600 w.) San Plumb—Jan. 15, 1897. No. 10,479. 15 cts.

PIPES and Piping: Patterns, Materials and Methods Best Suited for Plant and Line Construction and Maintenance. C. P. Russell (Suggestions of importance in the distributing department of gas plants, relating to the selection of proper piping, materials, &c. 3,400 w.) Am Gas Lgt Jour—Feb. 1, 1897. Serial, 1st part. No. 10,703. 15 cts.

PUSHING the Plumbing Business. C. Gill (The Ironmonger's second prize essay. Suggestions as to attractive display of plumbing appliances, obtaining favor of architects, real estate agents, &c. 1,500 w.) Dom Engng—Jan., 1897. No. 10,744. 30 cts.

REGULATIONS, New Haven Plumbing (A copy of the regulations which recently went into effect. 2,800 w.) Met Work—Jan. 23, 1897. No. 10,571. 15 cts.

MISCELLANY.

ADVANCEMENT of Architecture, with Some Remarks on the Study of Gothic. George Aitchison (First lecture to the Royal Academy students. Interesting study of the subject. 4,800 w.) Brit Arch —Jan. 29, 1897. No. 10,951. 30 cts.

ATHENS, Classic Architecture in. Fred J. Orr (Describes and illustrates types of architecture in an old city in Georgia. 1,800 w.) So Arch—Jan., 1897. No. 10,347. 30 cts.

BLOCKS, Ornamented Building. E. G. Durant (Describes the making of these blocks, and tells how they came to be introduced. 1,100 w.) Brick—Jan., 1897. No. 10,346. 15 cts.

BRICK Making in Australia. Frank W. N. King (Illustrated account of this industry, giving information of quality, wages, &c. 1,500 w.) Brick—Jan., 1897. No. 10,344. 15 cts.

BRICKWORK Tests (Report on the second series of experiments, by William C. Street and Max Clarke, with appendices by Prof. Unwin. Ill. 7,000 w.) Jour Roy Inst of Brit Arch'ts—Dec. 17, 1896. No. 10,515. 75 cts.

BRICKWORK Tests (Discussion of the report of the second series of experiments. 7,500 w.) Jour Roy Inst of Brit Arch'ts—Dec. 31, 1896. No. 10,674. 30 cts.

CLAYS, Mixing, Preparing and Burning (Information intended as aid for men of limited experience. 3,000 w.) Brick—Jan., 1897. No. 10,345. 15 cts.

DAMME, a City of the Netherlands. J. Tavenor Perry, in the Journal of the R. I. B. A. (Illustrated description of interesting architecture in a town founded in 1178. 1,500 w.) Arch and Build—Jan. 9, 1897. No. 10,333. 15 cts.

DECORATION, Modern. Jean Schpofer (Comments on the lack of progress in the nineteenth century in the art of ornamentation. Criticises the decoration of modern apartments and notes some efforts to give decoration a new direction. Ill. 3,500 w.) Arch Rec—Jan.-March, 1897. No. 10,629. 30 cts.

ELECTRIC LIGHTING, Architects and (An attempt to indicate some ways by which good electrical work may, by the help of the architect, be made obligatory and at the same time cheaper. 2,800 w.) Arch, Lond—Jan. 1, 1897. No. 10,385. 30 cts.

ENGLISH Architecture of 1896, The. Mr. Statham (Extract from article in "The Year's Art." Review of work completed and proposed and matters of interest relating to architecture. 1,600 w.) Brit Arch—Jan. 15, 1897. No. 10,610. 30 cts.

EXHIBITIONS, German Achievements in. L. von Krockow (The achievements of German architects in the fairs in Berlin and Dresden. 2,000 w.) Am Arch—Jan. 30, 1897. No. 10,701. 15 cts.

HANOVER Chapel. Paul Waterhouse (A tribute of appreciation of the qualities of a recently demolished building in Regent street, London, and of the architect. 1,800 w.) Jour Roy Inst of Brit Arch—Dec. 31, 1896. No. 10,672. 30 cts.

HARDENBERGH, Henry Janeway, The Works of. Montgomery Schuyler (Biographical sketch with illustrated description of the best work of this noted architect. 9,300 w.) Arch Rec—Jan.-March, 1897. No. 10,633. 30 cts.

INTERLACED Ornament, Celtic (Illustrated description of the beautiful designs used in stone, metal work, and illuminated manuscripts of ancient Irish art, with account of their origin. 1,500 w.) Arch, Lond—Jan. 1, 1897. No. 10,383. 30 cts.

PETERBOROUGH Cathedral: Actual State of the Front (Editorial condemnation of the method of restoration advocated by the Soc of Antiquaries. 3,500 w.) Builder—Jan. 23, 1897. No. 10,854. 30 cts.

PLASTERWORK, Decorative. E. Prioleau Warren (Read before the London Archts. Assn. suggestions as to the treatment of plaster work, its uses and abuses. 7,800 w.) Builder—Jan. 23, 1897. No. 10,855. 30 cts.

REFRIGERATION. Alfred Siebert (As applied to dwellings, hotels, hospitals, business houses and public institutions. 3,000 w.) Jour Assn of Engng Socs—Dec., 1896. No. 10,637. 30 cts.

SICILY, the Garden of the Mediterranean. Albert M. Whitman (An interesting article written in popular style, giving the history, description of the beautiful architecture and much information of this lovely island. Ill. 5,500 w.) Arch Rec—Jan.-March, 1897. No. 10,631. 30 cts.

STACKS, A Story of. See same title under Mechanical Engineering, Boilers, Furnaces and Firing.

STUDY of Architecture, The Proper George Aitchison (Address delivered to the students of the R. I. B. A. Presents the importance of diligence, and reviews the things of greatest importance to the success of architects. 3,200 w.) Brit Arch—Jan. 22, 1897. No. 10,853. 30 cts.

TALL BUILDINGS and the Speed of Elevators. George Hill (Letter to the editor placing the economical limit of height at sixteen stories, and giving suggestions for safety from fire and wind pressure. 900 w.) Eng Rec—Feb. 6, 1897. No. 10,923. 15 cts.

THOROUGHFARES, Characteristics of Some Great London (A series of articles enlarging upon the aspects of some of the London roads and streets, and calling attention to beauties and points of interest, with discussion of proposed changes. 2,000 w. Arch, Lond—Jan. 1, 1897. No. 10,382. 30 cts.

TWOMBLEY Estate, The (Some architectural, engineering and structural features of the improvement, arrangement and equipment of a park and model farm and buildings. Ill. 1,500 w.) Eng Rec—Feb. 6, 1897. No. 10,925. 15 cts.

VILLAS of Rome, The. Marcus T. Reynolds (Illustrated description of these beautiful buildings, with a study of the social causes that led to the erection of this type of dwelling. 9,500 w.) Arch Rec—Jan.-March, 1897. No. 10,630. 30 cts.

CIVIL ENGINEERING.

BRIDGES.

BRICKWORK and Masonry. (Editorial comment called forth by the extensive series of tests on the strength of brick piers being made under the direc tion of the Inst of British Archts. 1,600 w.) Engng—Jan. 1, 1897. No. 10,402. 30 cts.

BRIDGE from Fort Washington to Kingsbridge, New York City, A Proposed. (Brief illustrated description of design by W. B. Parsons. 400 w.) Eng News—Feb. 4, 1897. No. 10,901. 15 cts.

BRIDGE Transportation System Between New York and Brooklyn, The. (Full illustrated description, including engineering features, conditions of traffic, operation of cable railway, adoption of electricity, terminal facilities, and financial results. 4,700 w.) St Ry Jour—Feb., 1897. No. 10,728. 45 cts.

CORNER-STONE of a Structure. Origin

of Ceremonies Connected with the Laying of the. (From Le Genie Civil. Investigation of such observances, especially in the laying of the corner-stone of bridges. 1,100 w.) Eng News—Jan. 21, 1897. No. 10,555. 15 cts.

REPACKING a Main Truss Chord Pin. E. F. Terry (Letter giving illustrated description of method of changing bars in the bottom chord of a bridge. 600 w). Eng Rec—Jan. 30, 1897. No. 10,679. 15 cts.

ROCK ISLAND Bridge, The New United States. (Part first gives history and description, general data, requirements, manufacture and erection. Ill. 3,000 w.) Eng Rec—Jan 30, 1897. Serial. 1st part. No. 10,678. 15 cts.

STRESSES in Bridge Members, Maximum. L. N. Hoskins (Considers in as general a manner as possible the problem of determining what position of a given series of moving loads will produce the greatest stress in any member of a bridge truss. Mathematical discussion. 4,700 w). Trans of Wis Acad. Vol. X. No. 10,423. 45 cts.

CANALS, RIVERS AND HARBORS.

DANUBE-ELBE CANAL. The Danube-Moldan-Elbe Canal (Der Donau-Moldau-Elbe-Canal.) (An official account of the plans for the canal communication between Vienna and the North Sea. 15,000 w. and 3 plates of map and profiles.) Oesterr Monatscshr f d Oeffent Baudienst—Jan., 1897. No. 10,776. 30 cts.

DANUBE, Regulation of. Report of the Commission for the Regulation of the Danube at Vienna (Bericht der Donau-Regulierungs-Commission in Wien.) (The official report of the commission for the work done in 1895. 7,500 w.) Oesterr. Monatschrift f d Oeffent Baudienst—Jan., 1897. No. 10,775. 30 cts.

DEBRIS, Responsibility for. (Data aiming to prove that hydraulic mining was not the chief cause of the evils complained of, but that the Sacramento River has been raising its channel and increasing the swamps for centuries. 1,100 w.) Min & Sci Pr—Jan. 9, 1897. No. 10,425. 15 cts.

DRAINAGE Canal, The Chicago (This series of articles proposes to consider the immediate purpose of this great work, and to describe the manner in which the canal has been constructed. 3,400 w.) Engng —Jan. 1, 1897. Serial. 1st part. No. 10,398. 30 cts.

GALVESTON Harbor Works, The. W. J. Sherman (Illustrated historical account of the work of harbor improvement at this point. 3,000 w.) Jour Assn of Engng Socs—Dec., 1896. No. 10,639. 30 cts.

GREAT LAKES to the Sea, Joining the (Conclusions of the commission appointed by Pres. Cleveland to consider this matter. They think the plan feasible and make suggestions as to route. 1,000 w.) Bradstreet's—Jan. 23, 1897. No. 10,561. 15 cts.

INLAND NAVIGATION. The Waterways of France compared with those of Germany (Die Wasserstrassen Frankreichs, verglichen mit jenen Deutschlands.) (A comparison of the extent, carrying capacity and efficiency of the internal waterways of the two countries. 1,500 w.) Zeitschr d Oesterr Ing u Arch Vereines —Jan. 15, 1897. No. 10,756. 15 cts.

HARBORS and Waterways (Editorial review of changes and improvements during the past year. 2,000 w.) Eng, Lond—Jan. 1, 1897. No. 10,408. 30 cts.

LAKES to the Ocean, From the (Editorial on the report of the United States Deep Waterways Commission. 1,400 w.) RR Gaz —Feb. 5, 1897. No. 10,907. 15 cts.

NICARAGUA Canal Again, The (Editorial criticism of the attitude of the officers of the company, with statement of the situation. 900 w.) RR Gaz—Jan.fl 29, 1897. No. 10,684 15 cts.

NICARAGUA Canal, The (Editorial summing up briefly the situation. 1,500 w.) RR Gaz—Jan. 22, 1897. No. 10,567. 15 cts.

PANAMA Canal, The New (Showing the project as provisionally adopted. Profile is given. 1,800 w.) RR Gaz—Jan. 15, 1897. No. 10,458. 15 cts.

ROCK DREDGING on the Rhine (Brief illustrated description of an important work in progress in the bed of the Rhine, with methods employed and appliances used. 2,000 w.) Eng., Lond—Jan. 8, 1897. No. 10,510. 30 cts.

TOOLS Used in Construction of the New U. S. Lock at Sault Ste. Marie, Special (Illustrated description of devices easily made which served their purpose admirably. 900 w.) Eng News—Jan. 14, 1897. No. 10,449. 15 cts.

IRRIGATION.

HYDROGRAPHIC SURVEYS in Montana. A. M. Ryan (A review of the work done and the methods employed in the measurement of the flow of rivers and streams in Montana. 2,200 w.) Sch of Mines Quar—Nov., 1896. No. 10,936. 45 cts.

NAVAHO Reservation, Recent Irrigation Work on—Cosmos Mindeleff. (A brief illustrated account of the work to benefit the reservation, but largely devoted to description of the tribe inhabiting the region. 2,000 w.) Sci Am—Jan. 23, 1897. No 10,534. 15 cts.

WASHINGTON, Irrigation in Yakima County—A. B. Wyckoff. (An illustrated description endeavoring to show the results of irrigation. 1,500 w.) Sci Am Sup —Jan. 16, 1897. No. 10,438. 15 cts.

MISCELLANY.

BRICKWORK, Tests. See same title under Architecture, Miscellany.

CEMENT, Revision of the Method of Making Tests of (Report of the Board of Directors of the American Soc. of Civ. Engs., in the matter of the proposed appointment of a special committee to report on the proper manipulation of tests of cement. 800 w.) Eng. Rec.—Jan. 23, 1897. No. 10,596. 15 cts.

CIVIL ENGINEERING. (Review of the year in the various branches of civil engineering, with comment on the changed conditions. 3,300 w.) Eng Lond—Jan 1, 1897. No. 10,406. 30 cts.

CONCRETE, Wall on Clinton Ave., Brooklyn, The (Illustrated description of a public improvement by which waste lands along a branch of the East River will be converted into a public market-place, with buildings, piers and a basin and channel. 2,800 w.) Eng Rec—Jan 9, 1897. No. 10,334. 15 cts.

EXTENSION, of Amsterdam Avenue, New York, North from Fort George, Proposed (Illustrated description of a proposed extension by means of a steel viaduct and arches, which will greatly enhance the driving facilities of the northern part of Manhattan Island. 900 w.) Sci Am Sup—Feb. 6, 1897. No. 10,882. 15 cts.

JAPAN, Civil Engineering Prospects in (Notes of a few of the engineering projects which are being proposed as means for hastening the industrial and commercial development. 1,700 w.) Engng—Jan. 29, 1897. No. 10,945. 30 cts.

LIME, Hydraulic Cement, Mortar and Concrete. Clifford Richardson (This first part deals only with lime in its various forms. 1,800 w.) Br Build—Jan, 1897. Serial. 1st part. No. 10,658. 50 cts.

MONIER ARCH, The Theory of the Cement-Iron Construction—(Zur Theorie der Cement-Eisenconstruction—Monier Constructionen (A review of some previous articles, criticising the methods of computation used. By Prof. Josef Anton Spitzer. 2,500 w.) Zeitschr d Oesterr Ing u Arch Vereines—Jan. 8, 1897. No. 10,753. 15 cts.

SPEEDWAY, New York City, The Harlem River (Illustrated description, with editorial comment. 3,000 w.) Sci Am—Feb. 6, 1897. Serial. 1st part. No. 10,880. 15 cts.

TRANSVERSE Sections, The Resistance Areas of—A. E. Sharp. (Read before the Northeast Coast Inst of Engs. An explanation of the first principles of questions relating to beams and girders. 2,000 w.) Ind & Ir—Jan. 22, 1897. No. 10,721. 30 cts.

TUNNEL, Under the Spree, near Treptow, The (From Illustrirte Zeitung. Illustrated description of a tunnel undertaken to test the adaptability of the ground under Berlin for the construction of an underground railway. It is to form part of a future street railway from Treptow to the Silesian station. 900 w.) Sci Am Sup—Jan. 23, 1897. No. 10,543. 15 cts.

TOPOGRAPHICAL, Surveys, Their Methods and Value. J. L. Van Ornum (A lecture before the students of the College of Mechanics and Engineering, University of Wisconsin. Presents the value and utility of the topographical survey, with methods and variations in cost, scale and character of the work. Also notes showing how large a territory has been covered. 10,700 w.) Bul of Univ of Wis—Vol. 1, No. 10. No. 10,933. 35 cts.

VIADUCT at Sydney, N. S. W., Proposed Subaqueous (Illustrated description of a proposed plan to build a viaduct on top of the silt-bed, supported by piers carried down to the rock. 1,500 w.) Eng News—Jan. 21, 1897. No. 10,557. 15 cts.

WIND PRESSURES in the St. Louis Tornado. Julius Baier (The paper is presented with the object of placing on record some definite estimates made by the author, of the force exerted by the wind on several structures of known stability that failed under its action, and some further characteristic examples of destruction that will be indicative of this force. Ill. 21,500 w.) Pro Am Soc of Civ Engs—Jan., 1897. No. 10,737. 50 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BALTIC Ports, Trade with the (Discusses the possibilities of commerce in northern Europe. 1,600 w.) Tradesman —Feb. 1, 1897. No. 10,726. 15 cts.

COMMERCIAL Geography of Europe, The—Cyrus C. Adams (Calls the attention to the importance of geography as a basis of commerce. American merchants should know regions and their resources, people and their peculiar ways and tastes, &c. 2,800 w.) Chau—Feb., 1897. No. 10,668. 30 cts.

COMPETITION, Foreign—Joseph Nasmith (Abstract of an inaugural address before the Manchester Assn of Eng. Considers the three most important factors that affect the problem to be, 1st, the economic effect of approved appliances; 2d, the adoption of the best commercial methods; 3d, the fullest development of the skill of all those engaged in an industry, and especially of the leaders. 3,500 w.) Col Guard—Jan. 15, 1897. No. 10,585. 30 cts.

COMPETITION, German Trade (Editorial review of this subject and its effects, and the various causes that have led to the rapid growth of manufacturing industries in Germany. 3,500 w.) Engng —Jan. 29, 1897. No. 10,944. 30 cts.

EXPORT Trade, Pushing Our (Explains briefly the aims and purposes of the work of the Commercial Museums. 1,000 w.) Bradstreet's—Jan. 30, 1897. No. 10,675. 15 cts.

FAILURES, Records of (A statistical balance sheet, classified according to explained methods, and giving valuable information of credit ratings for the past six years. 9,000 w.) Bradstreet's—Jan. 23, 1897. No. 10,611. 15 cts.

IMPORT Duties in Foreign Countries on Dynomo-Electric Machinery and Electric Lamps (Statement of duties in the principal European countries and India, recently prepared by the English Board of Trade. 900 w.) Bd of Tr Jour—Jan., 1897. No. 10,692. 30 cts.

INDUSTRIES, The Future of American, —A. E. Outerbridge, Jr. (Address to students in economics and sociology in the Wharton School of Finance, University of Penna. An attempt to cast the horoscope of manufacturing industries in America for the opening of the new century. Growing expansion of commerce and manufactures and an era of industrial prosperity predicted. 3,500 w.) Jour Fr Inst—Feb., 1897. No. 10,918. 45 cts.

INTERCHANGE of Things Between Man and Man and Community, The Mechanism of (Syllabus of a lecture by Mr. Norman, given upon invitation of the Marylebone Teachers' Assn. The object was to demonstrate the progress secured by the use of one intermediary, entailing price and a rate of currency exchange, compared with exchange by direct barter. 1,000 w.) Bankers' Mag, Lond—Jan., 1897. No. 10,354. 30 cts.

JAPAN, The Commercial Expansion of. H. Tennant (A review of the remarkable progress of this country in recent years, calling attention to the advancement in commerce and manufactures and their effect on other countries, with discussion of the future probabilities. 4,000 w.) Contemporary Rev—Jan., 1897. No. 10,426. 45 cts.

PIG IRON, Southern (Extract from the London Iron and Steel Trades Journal, with letters from James Bowron, of the Tenn Coal & Iron Co. Remarkable growth of the foreign demand for it; countries to which it is exported; outlook for a continuation of the movement. 2,400 w.) Bradstreet's—Feb. 6, 1897. No. 10,928. 15 cts.

TARIFF Changes and Customs Regulations (Russia, Netherlands, Guiana, Belgium, Germany, France, Portugal, Southeast Africa, Spain, Cuba, Switzerland, Austria, Hungary, Turkey, United States, Mexico, Gautemala, Nicaragua, Costa Rica, Peru, Japan, British India, Natal and Leeward Islands. 11,000 w.) Bd of Tr Jour—Jan., 1897. No. 10.693 30 cts.

TARIFF, Revision of the (Letter to Hon. Nelson Dingley, Jr., Chairman of the Committee on Ways and Means, from the American Iron and Steel Assn, setting forth the views of the society on the question of a revision of the tariff. Gives a summary of the country's tariff history and considers changes believed to be required. 7,000 w.) Bul of Am Ir & St Assn—Feb. 1, 1897. No. 10,700. 15 cts.

CURRENCY AND FINANCE.

CURRENCY, The New Epoch and the—George S. Morison (Ascribes all the great advances of the nineteenth century to the capacity to manufacture power, and traces the effects. Traces the changes in business and shows the effect upon the currency. 4,700 w.) N Am Rev—Feb., 1897. No. 10,688. 45 cts.

GUINEA, The—(History of the coin with an estimate of its place and function in British monetary matters. 3,500 w.) Banker's Mag, Lond—Jan, 1897. No. 10,353. 30 cts.

MONETARY System, The Cure for a Vicious—W. A. Peffer (The steps that should be taken towards reforming the currency and placing the finances upon a stable basis. 4,500 w.) Forum—Feb. 1897. No. 10,691 30 cts.

MONEY and Investments. (Discusses the uncertainty of present conditions. 5,000 w.) Contemporary Rev—Jan., 1897. No. 10,427. 45 cts.

REFORM, Imperative, Financial and Currency—Charles N. Fowler, (Discusses the cause of trouble over the money question, and states that an unequivocal position with regard to the standard of value, the adoption of a well-developed system of credit currency, and the adjustment of revenues to meet the expenses of the Government, are essential to prosperity. 3,500 w.) Forum—Feb., 1897. No. 10,690. 30 cts.

GOVERNMENTAL CONTROL.

CRISES, The Relation of Economic—to Erroneous and Defective Legislation, with Special Reference to Banking Legislation. Edw. D. Jones (Deals with legislation from an historic point of view. A study of the theory of crises and their development, specially presenting the privileges of the bank of England and the Peel Bank act of 1844. 12,000 w.) Trans Wis Acad, Vol X—No. 10,424. 45 cts.

OWNERSHIP, Report of a Special Committee of the Northwestern Electrical Association on Municipal and Opposition

(Really two reports, one submitted by H. L. Doherty, the other by E. Coleman. Abstracts. The reports give no new information. 2,200 w.) Elec—Jan. 27, 1897. No. 10,642. 15 cts.

SUBWAYS, Municipal ownership of—See same title under Electrical Engineering, Miscellany.

TOLLS, Emancipation of the Monongahela from—Graphical Determination of Value of Franchises. Lewis M. Haupt (The importance of the improvement on the Monongahela, with method of determining value and the benefit of removing tolls. 1,700 w.) R R Gaz—Feb. 5, 1897. No. 10,904. 15 cts.

LABOR.

ARBITRATION in the Boot and Shoe Industry, Conciliation and. T. A. Carroll (Review of methods adopted and a study of results, obstacles, &c., with comparison of different plans. 17,300 w.) Bul of Dept of Labor—Jan., 1897. No. 10,468. 45 cts.

CONVICT Labor Problem, The. (Explains position taken in former article and further discusses the question. 1,800 w.) Gunton's Mag—Feb., 1897. No. 10,885. 30 cts.

LAND TAXATION and Labor Laws in New Zealand (Details of each different system under which land may be obtained in this colony; also reasons why the writer cannot encourage immigration from the United States, with discussion of labor conditions. 40,000 w.) Cons Repts—Jan., 1897. No. 10,488. 45 cts.

MR. CARNEGIE'S Johnstown Address (An extract giving the speaker's opinion of the cause of business depression and the relation of capital and labor. 1,800 w.) Ir Tr Rev—Jan. 28, 1897. No. 10,695. 15 cts.

PIECE WORK vs. Day's Work. See same title under Mechanical Engineering, Shop and Foundry.

PROFITS, Labor's Share of (Editorial showing that the benefit to the working classes from increased share of profits is not due to what the trade union advocates have done, but has followed upon events which were prompted by capital. The benefits arising from the Limited Liability Act are discussed. 1,800 w.) Engng—Jan. 15, 1897. No. 10,582. 30 cts.

MISCELLANY.

ARBITRATION Treaty, Anglo-American (Full text of the treaty as signed by the representatives of the two governments. 2,000 w.) Gunton's Mag—Feb., 1897. No. 10,886. 30 cts.

BETTERMENT, A Century of Social. John Bach McMaster (Reviews the great progress in methods of business, appliances which promote health, wages, comforts for all classes, advancement of science, material comfort and spirit of broad humanity. 4,500 w.) Atlantic M—Jan., 1897. No. 10,574. 35 cts.

ECONOMICS, Practical versus Metaphysical (Refers to the tendency to study economics from hypothetical rather than actual phenomena, and pronounces the doctrine of marginal utility to be unclear and unpractical. 4,000 w.) Gunton's Mag—Feb., 1897. No. 10,883. 30 cts.

FACTS versus Economic Theories. Hartley Withers (An extended criticism of the so-called science of economics, asserting that its study is an intellectual exercise, interesting but practically useless, and that if it is ever to be a science in the true sense, economists must study the phenomena of business much more closely. 4,000 w.) Bankers' Mag, Lond—Jan., 1897. No. 10,352. 30 cts.

GOLDSMITH'S, Trade and Its Relation to Wealth, The—Paul Gaultier (Brief historical review of the working of the precious metals and their effect upon the world. 2,700 w.) Chau—Feb., 1897. No. 10,669. 30 cts.

INVENTIONS. The Right of Employers to the Inventions of Employees (Das Recht des Dienstherrn an Erfindungen von Angestellten. An examination of this important subject, with recommendations in connection with German patent law. 2,500 w.) Glaser's Annalen—Jan. 15, 1897. No. 10,785. 15 cts.

LIVING, American Standard of (The variations in wages in different countries said to be due to the standard of living. Comparison with other countries is made, and the life of the workingman is shown to be broader in America than in Europe. 2,500 w.) Gunton's Mag—Feb., 1897. No. 10,884. 30 cts.

RUBBER Cultivation, the Outlook for—Gustav Mann (An interesting article in which the writer gives his opinion that all rubber plants had better be grown in the countries in which they are indigenous. This paper is followed by several short articles on related subjects. 1,500 w.) Ind Rub Wld—Feb. 10, 1897. No. 10,965. 45 cts.

STATISTICS (Editorial review of the blue-book of the Board of Trade; the forty-third issue of the Statistical Abstract for the U. K. in each of the last fifteen years. A study of the report shows fair indications of advancing prosperity. 4,000 w.) Engng—Jan., 1897. No. 10,401. 30 cts.

TECHNICAL Education in Germany, The Recent Progress of (Abstract of a report on the recent progress, dated Dec., 1896, and issued as a blue book. 1,800 w.) Col Guard—Jan. 22, 1897. No. 10,714. 30 cts.

ELECTRICAL ENGINEERING.

ELECTRO CHEMISTRY AND METALLURGY.

CHEMISTRY (Editorial review of the past year, containing report of progress in electro-chemistry and metallurgy. 2,500 w.) Eng, Lond—Jan. 1, 1897. No. 10,412. 30 cts.

CRUCIBLE Fusions, The Use of Electricity for—F. H. Leeds (Shows that wherever there is water-power available it is considerably cheaper to conduct crucible fusions by means of electricity than by direct coal firing; and that possibly in the future it may also be found advantageous to employ coal for the preparation of electricity, rather than to fire a crucible furnace with it direct. 2,400 w.) Elect'n—Jan. 22, 1897. No. 10,852. 30 cts.

CARBORUNDUM at Niagara Falls, The Manufacture and Development of. Francis A. Fitzgerald (Traces the manufacture of carborundum from the preparation of the crude material for the mixture to the production of grains and powders in a commercial form and considers its properties and uses. Ill. 5,500 w.) Jour Fr Inst—Feb., 1897. No. 10,916. 45 cts.

ELECTROLYSIS, New Carbon Terminals for (Neue Kohlen für Elektrolyse) (Lessing's new fused carbon sheets are for use in commercial electrolysis, and are claimed to be unaffected chemically or mechanically by the action of the bath. 1,000 w.) Elektrochemische Zeitschr—Jan., 1897. No. 10,793. 30 cts.

ELECTROLYSIS, The Separation of Metals by Means of Soluble Anodes (Trennung von Metallen mittelst löslicher Anoden) (A method of determining antimony quantitatively by electro deposition from solution upon a copper cylinder. 500 w.) Elektrochemische Zeitschr—Jan., 1897. No. 10,794. 30 cts.

FURNACE, Electric—for Distillation of Metals (Elektrischer Destillierofen) (A convenient laboratory furnace for distilling metals at very high temperatures. 800 w.) Elektrochemische Zeitschr—Jan., 1897. No. 10,795. 30 cts.

MECHANICAL Theory of Electricity and Chemical Action. Arthur Whitwell (The object is to develop the idea of molecular rotation and to suggest by its aid a mechanical picture of electrostatic, electromagnetic, magnetic and chemical phenomena. 1,600 w.) Elec Rev, Lond—Jan. 8, 1897. Serial, first part. No. 10,495. 30 cts.

REVIEW Electro-Chemistry in 1896 (Elektrochemie im Jahre 1896) (A general review of the progress of this branch of science for the past year, with numerous references to journals and patents. 7,500 w.) Elektrochemische Zeitschr—Jan., 1897. No. 10,796. 30 cts.

LIGHTING.

ARCHITECTS and Electric Lighting. See title Electric Lighting, under Architecture. Miscellany.

ARC Lighting, Fifteen Years' Progress in—Elihu Thomson (A review of the period which covers nearly all the commercial development of arc lighting on a large scale. 2,000 w). Elec Eng—Jan. 6, 1897. No. 10,315. 15 cts.

ARC Light, The Enclosed—L. B. Marks (Read before the Société Internationale des Electriciens, Paris, France. Points out the distinction between the ordinary arc and the enclosed arc; gives a sketch of the earlier history of the art of enclosing arc lighting, with details of the subject. 1,800 w). Elec Eng—Jan 27, 1897. Serial. 1st part. No. 10,650. 15 cts.

BIRKENHEAD Electricity Works. (Illustrated detailed description. 3,700 w.) Elec Eng, Lond—Jan. 15, 1897. No. 10,622. 30 cts.

BRITISH GUIANA, Electric Lighting in—Samuel Vyle (Brief account of the introduction. 1,500 w). Elect'n—Jan. 29, 1897. No. 10,950. 30 cts.

CENTRAL STATION Economics. Arthur V. Abbott and Franz J. Dommerque (A collection of information particularly relative to central station practice, arranged in form for ready reference, intended to embrace all information of value as relating to profitable design and operation of central stations. 41,500 w). Elec Engng—Feb., 1897. No. 10,738. 25 cts.

CENTRAL STATION Operation, Fifteen Years in. Samuel Insull (A history of development and growth. 2,200 w). Elec Eng—Jan. 6, 1897. No. 10,316. 15 cts.

DISTRIBUTION and Diffusion of Light. E. L. Elliott (Abstract of a paper read before the N. Y. Elec. Soc. The problems of distribution and diffusion are discussed and the effect of various globes. 2,800 w). Elec Wld—Jan. 23, 1897. No. 10,660. 15 cts.

GAS ENGINE, The Determination of the Cost of Electric Lighting by—J. L. Christy and S. A. Hasbrouck (Abstract of thesis submitted before the Stevens Inst. of Technology. Describes engine and gives tables of tests containing data taken at the engine; the averages for each test, and a table of comparison of costs at different loads. 1,000 w). Am Gas Lgt Jour—Jan. 25, 1897. No. 10,608. 15 cts.

INCANDESCENT Lamps. Franklin S. Terry (Abstract of paper read before the Northwestern Elec. Assn. Points of Practical interest to the central station. 2,500 w). Elec Eng—Jan. 27, 1897. No. 10,651. 15 cts.

INCANDESCENT Lamp, Past and Future, The (Review of the changes and their effect upon the industry at large. 1,100 w). Elec Eng—Jan. 6, 1897. No. 10,319. 15 cts.

ISLE OF MAN, Electricity in the. (Extract from report of the Town Clerk of Douglas, in which the cost of electric lighting is dealt with. 2,000 w). Gas Wld—Jan. 2, 1897. 30 cts.

ISOLATED Electrical Plant During the Last Fifteen Years, The Evolution of the —Charles Henry Davis (Treats of the isolated plant located in the building which it serves. Part first describes the generating plant. 700 w). Elec Eng—Jan. 6, 1897. Serial. 1st part. No. 10,314. 15 cts.

ISOLATED Plants. Cost of Electric Lighting from Public and Private Supply. F. J. Warden-Stevens (Curves, with explanation, showing cost of lighting from supply mains and from a private plant, given in order to show approximately when it is advisable to adopt a separate plant. 1,300 w). Elec Rev, Lond—Jan. 8, 1897. No. 10,496, 30 cts.

ISOLATED Plant. Electric Lighting at the New Waldorf Hotel, N. Y. (Brief description of what will be one of the most extensive plants of its kind in the country. 600 w.) Elec Rev—Jan. 13, 1897. No. 10,415. 15 cts.

LAUNCESTON, Tasmania, the Lighting of (Illustrated detailed description. 4,200 w.) Elec Rev, Lond—Jan. 1, 1897. No. 10,392. 30 cts.

MALTA Electricity Supply (Illustrated detailed description. 2,400 w). Elec Rev, Lond—Jan. 22, 1897. No. 10,858. 30 cts.

MANCHESTER Corporation Electric Works. C. H. Wordingham (Describes the five-wire method, the distributing network, insulating troughs, cables, feeders, generating plant, engines, boilers and extensions. 3,800 w). Prac Eng—Jan. 22, 1897. No. 10,859. 30 cts.

MUNICH, The Electric Plant of the City of (Die Städt ischen Elektricitätswerke Münchens. A very complete account of the steam and hydraulic power plant, electric generators, lighting and distribution, with numerous illustrations. 6,000 w). Elektrotechniscshe Zeitschr—Jan. 7, 1897. No. 10,797. 15 cts.

MUNICIPAL OWNERSHIP. See title Ownership, under Economics and Industry, Governmental Control.

STATIONS, Pioneer Electric Light (Brief historical sketch of the Kensington Court Station, with a résumé of improvements already added or in course of construction. 2,500 w.) Elec Eng, Lond—Jan. 1, 1897. No. 10,396. 30 cts.

STEAM ENGINEERING of To-Day and To-Morrow, The—R. H. Thurston (The article deals with the subject of the steam engine for electric lighting principally, reviews progress and describes the modern engine. 2,800 w). Elec Eng—Jan. 6, 1897. No. 10,317. 15 cts.

ST. HELENS, Electricity Works (Illustrated detailed description. 3,300 w.) Elec Eng, Lond—Jan 15, 1897. No. 10,623. 30 cts.

TRANSFORMERS, Protective Devices for—Herbert C Wirt (Read before the Northwestern Elec Assn. Calls attention to devices which have been designed to render the transformer absolutely safe. Also suggests precautionary measures. 1,800 w). Elec Rev—Jan. 27, 1897. Serial 1st part. No. 10,643. 15 cts.

WIRING, Free (Discussion from the private householder's point of view, and with relation to the effect on the supply, undertaking and the cost per unit. 1,800 w.) Elec, Lond—Jan 1, 1897. No. 10,490. 30 cts.

UNDERGROUND Lighting by Electricity, Notes on—John Daw (Read before the Inst of Min and Met. Brief description of a portable electric lamp. 1,400 w.) Min Jour—Jan 23, 1897. No. 10,716. 30 cts.

POWER.

ADVANCE in the Near Future, Lines of—H. H. E. (Discusses the possibilities for the useful application of the electric current, predicting that it will find its greatest activity in industrial establishments, 800w). Ir Tr Rev—Jan. 21, 1897. No. 10,621. 15 cts.

BROOKLYN BRIDGE, New Electric Power Plant, The (Illustrated detailed description, with a few statistics relating to the construction and operation of the bridge. 4,300 w.) Elec Wld. Jan. 23, 1897. No. 10,659. 15 cts.

CENTRAL Electric Station of the Davis Coal and Coke Co. Timothy W. Sprague. (Illustrated description of plant and its operation. 2,200 w.) Eng & Min Jour. Jan. 23, 1897. No. 10,560. 15 cts.

DISTRIBUTION of Power in Workshops, &c., The Local—Ernest Kilburn Scott. (Presents the advantages of electric transmission in factories and workshops. 2,500 w.) Elec Eng Lon—Jan. 1, 1897. Serial. 1st part. No. 10,395. 30 cts.

DYNAMO. Elementary Practical Electricity. F. L. Hutchinson. (Designed to explain in a simple manner the fundamental principles upon which dynamos and motors depend in their action. 1,500 w.) Ry Mas Mech—Jan., 1897. Serial, 1st part. No. 10,349. 15 cts.

ECONOMIES of Electrical Transmission of Power, The—Walter Dixon (Part first reviews the methods for distributing power in iron and steel works, and shows that the results can be immeasurably improved by the application of electricity. 2,200 w.) Ir & Coal Trds Rev—Jan. 22, 1897. Serial. 1st part. No. 10,720. 30 cts.

ELECTRIC, Central Stations versus Isolated Plants. R. S. Hale (Controverting analytically the claim of Max Osterberg, that the isolated plant will gradually displace the Central Station. 4,800 w.) Eng Mag—Feb., 1897. No. 10,299. 30 cts.

ELECTRICITY in the Government Printing Office. (Abstracts of reports of Chief Engineer George E. Ried and Chief Electrician W. H. Tapley, giving valuable details of the operation and economy of the plant. 4,000 w.) W Elec—Jan. 30, 1897. No. 10,702. 15 cts.

EQUALIZER, The (Explains the action of the Equalizer. 1,500 w). Am Elect'n—Jan., 1897. No. 10,546. 15 cts.

EQUIPMENT of Manufacturing Establishments with Electric Motors and Electric Power Distribution, The. Dugald C. Jackson. (Summary of views held in various great establishments where experience has been had, dealing especially with conditions existing in concerns owning and operating their own plant. Compares mechanical and electrical distribution. 7,400 w.) Jour of W Soc of Engs—Dec., 1896. No. 10,472. 45 cts.

EQUIPMENT of the Hotel Manhattan, The Electrical (Brief illustrated description of the complete electrical equipment which has been installed in this hotel. 2,500 w.) Elec Wld—Jan. 9, 1897. No. 10,441. 15 cts.

FARMS, Electricity on (Description of an electrical plant as introduced on a farm in Mecklenburg. Shows a difference in expenses of $285.60 in favor of the electric plant. 1,000 w.) Cons Repts—Jan., 1897. No. 10,578. 45 cts.

GENERATING Electricity, Motive Power for (Review of E. Tremlett Carter's "Treatise on the Theory of the Mechanical Equipment of Power Stations," quoting also from N. W. Perry's paper favoring the use of gas engines for generating electricity. 2,000 w). Jour of Gas Lgt—Jan. 5, 1897. No. 10,445. 30 cts.

GENERATOR, The design of 100 K. W. 500 Volt Power—H. J. Ryan and I. J. Macomber (The two general methods that may be used for designing a dynamo are stated, with outlines and explanatory notes for the design of direct current generators and motors. 5,500 w.) Sibley Jour of Engng—Jan., 1897. No. 10,635. 30 cts.

MINING PURPOSES, The Use of Electrical Power for (The series of articles proposes to consider the suitability of the system to general mining conditions in competition with other power systems and the circumstances under which it is in actual practice, and may be applied to coal-cutting, haulage, pumping, lighting and other purposes. 2,200 w.) Ir & Coal Trds Rev—Jan. 15, 1897. Serial. 1st part. No. 10,595. 30 cts.

NIAGARA, The Acccomplished Utilization of—W. B. Rankine (Data as to the result of the enterprise, with a list of contracts for power to Nov., 1896. 600 w.) Elec Eng—Jan. 6, 1897. No. 10,321. 15 cts.

NIAGARA Power Celebration, The Buffalo (Account of the banquet given Jan. 12, 1897, in celebration of the successful power transmission. 5,600 w.) Elec Eng—Jan. 20, 1897. No. 10,525. 15 cts.

PAPER MILLS. The Electric Transmission of Power in the Paper Mill at Biberist (Die Elekhrische Kraftübertagung der Papier-fabrik Biberist). This is one of the longest in Europe, 365 H. P. being transmitted nearly 18 miles. 4,000 w.) Elektrotech Rundschau—Jan. 15, 1897. No. 10,788. 15 cts.

PATERSON, N. J., New Station of the Edison Electric Illuminating Company of (The company furnishes not only arc and incandescent light and miscellaneous power, but also the current for operating the electric railroad. Illustrated description. 1,800 w.) Power—Feb., 1897. No. 10,872. 15 cts.

PROGRESS in the Adaptation of Electricity. M. J. H. (A review of recent progress due to the development of the transmission of power over long distances, especially in mining work. 2,000 w.) Ir Tr Rev—Jan. 21, 1897. No. 10,620. 15 cts.

SHUNT MOTOR, Practical Method of Differential Compounding a—for Constant Speed at All Loads. Reese Hutchison (A practical and reliable way is described. 600 w.) Am Electn—Jan., 1897. No. 10,545. 15 cts.

SPEED and Efficiency of a Dynamo, Note on the Relation Between the—Arnold G. Hansard (A graphic solution of this problem, giving the rather unexpected result that the speed which gives the highest efficiency is that which makes the eddy-current losses equal to the C2R losses. 700 w.) Elect'n—Jan. 22, 1897. No. 10,851. 30 cts.

STORAGE BATTERY to Electric Traction, The Application of the—Charles Hewitt (Deals with the application of the battery on the car or locomotive, to long lines, and in the power-house itself, giving two applications in the writer's personal experience. The writer thinks there is a wide and growing field in the application to long lines and in the power-station, but not to moving vehicles. Ill. 6,500 w.) Pro Engs Club of Phila—Jan., 1897. No. 10,967. 45 cts.

THREE-WIRE Distribution, New Dynamo for—M. Aliamet (From L'Electricien. Illustrated description of arrangements for enabling the two sides of the three-wire system to be fed by means of a single dynamo, and the solution of the problem by M. Müller. 900 w.) Elec Rev Lond—Jan. 22, 1897. No. 10,857. 30 cts.

TRANSFORMERS, Improvements in Continuous Current (Calls attention to modifications of the original scheme by which the generating plant has been simplified and low-pressure distribution arranged on a three-wire system. The full load efficiency has been increased more than 5 per cent. in less than two years. Ill. 1,000 w.) Electn—Jan. 8, 1897. No. 10,512. 30 cts.

TRANSMISSION, Long Distance—Charles P. Steinmetz (Reviews the progress of transmission for lighting, mechanical power and electric railroading. 1,600 w.) Elec Eng—Jan. 6, 1897. No. 10,320. 15 cts.

TRANSMISSION, Recent Advances in Power—John McGhie (Showing the important place now occupied by electric power. 900 w.) Elec Eng—Jan. 13, 1897. No. 10,432. 15 cts.

WATER WHEELS, The Efficiency of. F. M. F. Cazin (Letter to the editor criticizing statements made in an article by Wm. Blaue, published Sept. 12, 1896. Also showing the importance to the electrician of water-wheel efficiency. 1,300 w.) Elec Wld—Jan. 9, 1897. No. 10443. 15 cts.

WORKS Operated by Electricity, Nut and Bolt. (Describes and illustrates the factory of Messrs. Plumb, Benedict & Bernard at North Tonawanda, N. Y., which is to be operated by power from Niagara. 900 w.) RR Gaz—Jan. 29, 1897. No. 10683. 15 cts.

WORM-GEARING, Electrical Tests of the Efficiency of. (Diagrams showing results of actual tests upon the double-worm elevator of the Sprague Electric Elevator Co. 1,800 w.) Am Mach—Jan. 21, 1897. No. 10550. 15 cts.

TELEGRAPHY AND TELEPHONY.

BELL TELEPHONE Exchange at Larchmont, New Southern (Illustrated description. 500 w.) Elec Eng—Jan. 13, 1897. No. 10,434. 15 cts.

BERLINER Patent Situation, The (Gives the more important portions of the Patent Office records which bear directly upon the invention of the microphone. 4,700 w.) Elec Wld—Jan. 30, 1897. No. 10,862. 15 cts.

DUPLEX, The Müller-Wilke Telegraph-Telephone (Müller-Wilke's Telegraphen-Fernsprecher. A system of simultaneous telegraphing and telephoning over a single wire, especially adapted for railway service. 2,500 w.) Deutsche Zeitschr. f. Elektrotech—Jan. 15, 1897. No. 10,792. 15 cts.

INTERNATIONAL Telegraphs (Particulars from official and other sources relating to the International Bureau of the Telegraphic Administrations. 3,000 w.) Elect'n—Jan. 15, 1897. No. 10,604. 30 cts.

KITES, The Use of a Mid-Air Telephone Wire with—Wm. A. Eddy (An illustrated account of a successful experiment. 1,200 w.) Elec Eng—Jan. 6, 1897. No. 10,324. 15 cts.

PARTY LINE Telephone Systems, Recent Improvements in (Description of a system brought out by the American Telephone and Telegraph Co. Illustration of instrument. 1,000 w.) Elec Eng—Jan. 27, 1897. No. 10,649. 15 cts.

RICHMOND Telephone System, The (Illustrated description. 2,300 w.) Elec Wld—Jan. 16, 1897. No. 10,520. 15 cts.

SUBMARINE Cablegraphy, Fifteen Years' Advance in—George G. Ward (Review of improvements and advances as observed in the North Atlantic. The points noted are the increase in facilities, rapidity, legibility, accuracy and cheapness of service. 1,300 w.) Elec Eng—Jan. 6, 1897. No. 10,323. 15 cts.

SUBMARINE Cables, Localizing Earth Faults in—by Tests from One End Only. J. Rymer (Explains a test, capable of great accuracy, where results from one end only have to be relied upon to determine the position of a partial earth or broken conductor. 3,000 w.) Elec Rev Lond—Jan. 1, 1897. No. 10,391. 30 cts.

SUBMARINE Telegraphy (Presidential address of Sir Henry Mance to the Inst. of Elec. Engs., with biographical sketch of the speaker. Many interesting points connected with this work are brought out, with notes from personal experience. 7,500 w.) Elect'n—Jan. 15, 1897. Serial, first part. No. 10,605. 30 cts.

TELEGRAPHY, Fifteen Years of—William Maver, Jr. (A review of changes some of them very important, and of improvements in submarine telegraphy, of the increase of mileage and other interesting points. 3,000 w.) Elec Eng—Jan. 6, 1897. No. 10,322. 15 cts.

TELEPHONY, Dr. V. Wietlisbach (A republished revised edition of the first 110 pages of this work which the writer is contributing to Electrical Engineering. It is said to be the most thorough and complete work on telephony ever written. 3,000 w.) Elec Eng—Jan., 1897. No. 10,355. 25 cts.

MISCELLANY.

ALTERNATING Currents, Conductor Resistance Met by. Dugald C. Jackson (A consideration of "skin-effect" and its importance, with the development of formulae. 1,200 w.) Elec Wld—Jan. 16, 1897. No. 10,521. 15 cts.

ALTERNATING, Direct Currents from. Albert G. Davis (Illustrated description of a device for converting alternating currents into direct, and vice versa. It depends on the trigonometrical principle that the square of the sine plus the square of the cosine equals unity. 700 w.) Elec Wld—Jan. 9, 1897. No. 10,440. 15 cts.

ARC. On the Effect of Pressure in the Surrounding Gas on the Temperature of the Crater of an Electric—Correction of Results in a Former Paper. W. E. Wilson and G. F. Fritz (Researches to determine, if possible, whether the temperature of the crater in the positive carbon varies with change of pressure in the surrounding medium. 2200 w.) Elect'n—Jan. 8, 1897. No. 10,513. 30 cts.

ARMATURES, Balancing. See title "Balancing" under Mechanical Engineering, Shops and Foundry.

CATHODE RAYS, An Experiment showing the Deflection of—by a Magnetic Field. J. A. Fleming (An illustrated description or an interesting experiment. 700 w.) Elect'n—Jan. 1, 1897. No. 10,370. 30 cts.

CLARK CELLS, Variation in the Electromotive Force of—with Temperature. W. E. Ayrton and W. R. Cooper (Dials with the temperature variations and their effect upon the accuracy of this standard. 3,800 w.) Elect'n--Jan. 1, 1897. No. 10,371. 30 cts.

COAL, Electricity from—with and without Heat. Willard E. Case (A résumé of some of the efforts to solve this problem. 1,700 w.) Elec Eng—Jan. 6, 1897. No. 10,318. 15 cts.

DI-ELECTRICS, The Viscosity of Polarized (Describes a method of testing that can be applied to very viscous liquids, and reviews results that have been obtained by experimenters. 1,300 w.) Elec Rev, Lond—Jan. 15, 1897. No. 10,613. 30 cts.

EDUCATION. Electrical Engineering—Francis B. Crocker (Sketches the advance in applied electricity as representative of the changes in electrical education, the latter being moulded by the former. Prior to 1882, knowledge of the science was acquired by experience, or was self-taught. Results and criticisms of present educational methods are stated. 3,300 w.) Elec Eng—Jan. 6, 1897. No. 10,331. 15 cts.

ELECTRICAL PROBLEMS at the Chicago Cycle Show of 1897. D. Avery Kimbark (An account of the work necessary to furnish the current to light the building, furnish current for display signs, automatic apparatus, motors and general illumination for exhibitors. 5,000 w.) W Elec—Feb. 6, 1897. No. 10,908. 15 cts.

ENGINEERING, Electrical (Editorial review of the past year in Great Britain, showing a decided improvement in business over the two previous years. 3,000 w). Eng, Lond—Jan. 1, 1897. No. 10,409. 30 cts.

EXHIBITION. The Electrical Exhibition at Stuttgart, 1896 (Die Ausstellung für Electrotechnik in Stuttgart, 1896) (With illustrations of gas and petroleum motors, motor carriages, electrically driven tools, and one plate of 10-ton electric travelling crane. 5,000 w.) Zeitschr Ver Deutscher Ing—Jan. 16, 1897. No. 10,764. 20 cts.

EXPORT Trade, The Beginnings of Electrical. A. A. Knudson (Statistics claiming to be authentic, with information on the past and present condition and future possibilities. 2,800 w.) Elec Eng—Jan. 6, 1897. No. 10,325. 15 cts.

GENERATOR. A New Three-Wire Machine (Eine Neue Dreileiter Maschine). (An illustrated description of the new generator for use with the three-wire system, built by Lahmeyer, of Frankfurt-a-M. 2,500 w.) Elektrotech Rundschau—Jan. 1, 1897. No. 10,786. 15 cts.

GOVERNOR for Electrical Work, A New Steam Engine. C. Percy Taylor (Description of a new governor, which claims to fulfil the necessary conditions required in electrical work. 1,000 w.) Elect'n—Jan. 15. No. 10,606. 30 cts.

INCANDESCENT Lamps vs. Commercial Heaters. E. Y. Porter and C. D. Warner (Experiments at the University of Nebraska. A comparison of the heating effect of incandescent lamps with that of the usual form of electric heaters. 1,500 w.) Elec Eng—Jan. 20, 1897. No. 10,526. 15 cts.

INDUCTION Balance, Preliminary Trial of an Interferential. C. Barus (Describes a device capable of a variety of applications in relation to alternating currents and to magnetic induction. 3,300 w.) Am Jour of Sci—Feb., 1897. No. 10,689. 45 cts.

INDUCTION Coil, How to Make an. George T. Hanchett (Illustrated description of recent improvements. 1,500 w.) Am Elect'n—Jan., 1897. No. 10,547. 15 cts.

MAGNETIC Fields of Coils, On the. W. H. Everett (Proof of necessary formulae and some examples of their use. 2,500 w.) Elec Eng, Lond—Jan. 8, 1897. No. 10,536. 30 cts.

MAGNET, The Great Gun. W. R. King (Some measurements of the magnetic strength. Ill. 1,600 w.) Elec Rev—Feb. 3, 1897. No. 10,867. 15 cts.

MEASUREMENTS, Electrical. W. A. Anthony (Review of advances in the art of electrical measurements, the more important of which is the final establishment of the values of the fundamental electric units. 2,000 w.) Elec Eng—Jan. 6, 1897. No. 10,328. 15 cts.

MECHANICAL Construction of Electrical Machinery. See "Electrical" under Mechanical Engineering, Shop and Foundry.

METRIC System in Electrical Industries, The. F. S. Hickok (Read before the Chicago Elect. Assn. Discusses the inconvenience of multiple systems of measurement, and the effect, upon the general adoption of the metric system, of the present adoption of eight electrical units, based on the metric system of weights and measures. 2,000 w.) Elec—Jan. 20, 1897. Serial. 1st part. No. 10.533. 15 cts.

MINES, Electricity in. See title "Electricity" under Mining and Metallurgy, Mining.

PATENTS and Electrical Inventions. Henry C. Townsend (A review of the difficulties and annoyances from which electrical inventors have suffered. 1,600 w.) Elec Eng—Jan. 6, 1897. No. 10,327. 15 cts.

RADIATION. C. M. Dorman (Presidential address before the Northern Soc. of Elec Engs. Investigation of vibrations and waves and their application to electricity. 3,500 w.) Elec Eng, Lond—Jan. 22, 1897. Serial. 1st part. No. 10,856. 30 cts.

REPAIRS of Machinery. See title "Electrical Machinery," under Mechanical Engineering, Shop and Foundry.

ROENTGEN Rays, Electrification of Air by—Lord Kelvin, Dr. J. C. Beattie and Dr. Smoluchowski de Smolan (Read before the Royal Soc. of Edinburgh. Illustrated description of arrangements of the test whether or not Roentgen rays have any electrifying effect on air. 800 w.) Nature —Dec. 31, 1896. No. 10,397. 30 cts.

ROENTGEN Rays, Medicinal Properties of. William G. Caffrey (Communication to the editor claiming material benefits from treatment by these rays. 1,000 w.) Elec Wld—Jan. 9, 1897. No. 10,444. 15 cts.

SAFETY FUSES, The Reasonable Method of Rating and Testing. Frederic A. C. Perrine (Comments on the disagreement of experimenters and engineers in their understanding of the proper use of fuses in circuits, and suggests the true method of testing. 1,700 w.) Elec Wld—Jan. 30, 1897. No. 10,860. 15 cts.

SECOHMMETER as Used in the Electrical Engineering Laboratory, The. W. H. Freedman (Illustrated description of apparatus and its uses. 1,800 w.) Sch of Mines Quar—Nov., 1896. No. 10,937. 45 cts.

STORAGE BATTERY Compartments, Lining for (The method of making the batteries acid-tight and of insulating, as detailed in a communication from the Hanover Street Railway Co. 1,000 w.) Elec Eng—Jan. 6, 1897. No. 10,330. 15 cts.

SUBWAY System of Baltimore, The Proposed Municipal Electric (Brief abstract from the report of Nicholas S. Hill, Jr., Engineer of the Electrical Commission of Baltimore, which has this work in charge. This report is said to be about the best treatise in existence upon the subject of electrical subway construction and management. 1,200 w.) Eng News—Jan. 28, 1897. No. 10,666. 15 cts.

SUBWAYS, The Municipal Ownership of Electric (Discusses the question of ownership of the conduits when wires are put under ground, giving the practice in Baltimore and St. Louis, and gives some opinions as to the best system, profits, &c. 1,700 w.) Eng News—Jan. 28, 1897. No. 10,664. 15 cts.

SUBWAY Work, Progress of Electrical. William Weaver, Jr. (Illustrated description of the work, principally as carried out in New York. 1,800 w.) Elec Wld—Jan. 30, 1897. No. 10,861. 15 cts.

SUPPLY HOUSE, Past and Present, The Electrical. W. H. McKinlock (A review of the industry. 1,200 w.) Elec Eng—Jan. 6, 1897. No. 10,329. 15 cts.

SUSPENSION, On a Method of Delicate. Frank A. Laws (Calls attention of those engaged in physical work, especially electrical testing, to a device due to Dr. W. H. Julius, of Amsterdam, by which the effects of mechanical disturbance may be eliminated. 700 w.) Elec Wld—Jan. 16, 1897. No. 10,519. 15 cts.

TESLA on Electricity (His address in full on the occasion of the commemoration of the introduction of Niagara Falls power in Buffalo. Given at the Endicott Club, Jan. 12, 1897. 6,000 w.) Elec Rev.—Jan. 27, 1897. No. 10,644. 15 cts.

THEFT OF ELECTRICITY. (Diebstahl an Elektrizität) (A Discussion by Dr. Dernberg as to the legal nature of electricity as a "product," in cases of stealing current from wires for power or lighting. 2,000 w.) Elektrotech Rundschau—Jan. 15, 1897. No. 10,787. 15 cts.

VOCAL REGISTER, The Development of the Higher—by Electricity. William Harvey King (The purpose is to illustrate the action of the electrical currnet in developing the muscles of the larynx. 2,000 w.) Elec—Jan. 20, 1897. Serial. 1st part. No. 10,532. 15 cts.

WELDING, Electrical. Sydney F. Walker (Read before the Bristol Channel Center of the Inst. of Marine Engineers, in the engn'g laboratory of University College, Cardiff. The processes described are the Thomson system, Dr. Zerenor's system and the Bernardos process. 3,200 w.) Elec Eng, Lond—Jan. 8, 1897. No. 10,537. 30 cts.

WIRE and Cable Manufacture, The Improvement in. Henry A. Reed (Synopsis of the development of the insulated wire industry during the past fifteen years. 1700 w.) Elec Eng—Jan. 6, 1897. No. 10,326. 15 cts.

MARINE ENGINEERING.

BOILERS AND ENGINES.

BEARINGS of the Marine Engine, The. John Dewrance (Read before the Inst. of Marine Engs. An explanation of the way oil enables a bearing to support its load, and a discussion of the modifications in design of marine engine bearings consequent upon a right understanding of the principles of lubricatioin. 1,600 w.) Engng —Jan. 1, 1897. No. 10,403. 30 cts.

WATER TUBE Boiler, Evaporative Trials of an Almy (Report of a test made by George H. Barnes in the shops of the company at Providence, R. I. Data and results. 1,500 w.) Am Eng & R R Jour—Feb., 1897. No. 10,698. 30 cts.

WATER-TUBE Boilers. Liquid Fuel (Extracts from the Year Book of the Office of Naval Intelligence giving information on the subjects named. 2,500 w.) Am Eng & RR Jour—Feb., 1897. No. 10,697. 30 cts.

WATER-TUBE Boilers. G. L. Burton (Read before the Liverpool Eng. Soc. Abstract. Describes types and presents advantages and disadvantages. 3,200 w.) Steamship—Jan., 1897. No. 10,393. 30 cts.

NAVAL AFFAIRS.

ARMOR PLATE. See same title under Mining and Metallurgy, Iron and Steel.

MECHANISM of Our Ships of War, The (Editorial comment on the complexity of the apparatus and contrivances for manoeuvres and actions, urging attention to simplification. 1,600 w.) Eng, Lond—Jan. 8, 1897. No. 10,509. 30 cts.

"SWORDFISH" and "Spitfire," The Engines of H. M. SS. (Illustrated description of engines fitted into two torpedo-boat destroyers. Presents some novel features in the arrangement of valves. 1,600 w.) Engng—Jan. 15, 1897. No. 10,581. 30 cts.

"TERRIBLE," H. M. S. (Report of the steam trials, with details of her performance, and editorial on the facts brought out. 3,200 w.) Eng, Lond—Jan. 15, 1897. No. 10,588. 30 cts.

"TERRIBLE," The Trials of H. M. S. (Full account of the official steaming trials, with results and details. The great success of the Belleville boiler. 3,500 w.) Engng—Jan. 15, 1897. Serial. 1st part. No. 10,583. 30 cts.

TORPEDO-BOAT Destroyers "Furor" and "Terror" (Illustrated description. 15,000 w.) Engng—Jan. 1, 1897. No. 10,400. 30 cts.

MISCELLANY.

BAZIN ROLLER SHIP (Das Rollende Schiff von Bazin.) A description and illustration of this novel vessel, soon to be tried on the English Channel. 1,000 w.) Oesterr Monatschr f d Oeffent Baudienst—Jan., 1897. No. 10,780. 30 cts.

RESISTANCE of Ships. Joseph R. Oldham (Read at meeting of Civ. Engs' Club, of Cleveland, O. Part 1st is a study of the friction of solid bodies. 1,100 w.) Am Ship—Feb. 4, 1897. Serial. 1st part No. 10,895. 15 cts.

ROLLER BOAT of Mons. Bazin, The. Emile Gautier (A popular and general account of this invention, with discussion. 7,500 w.) Jour Soc of Arts—Jan. 22, 1897. No. 10,749. 30 cts.

SANITATION of Vessels. The Sanitary Arrangements of the Modern Steamship. (Die gesundheitlichen Einrichtungen der modernen Dampfschiffe, by C. Busley.) (A very complete series of articles describing the arrangements for ventilating, draining, lighting, water supply &c., of modern vessels. 3 articles. 2,500 w.) Zeitschr, d. Ver. Deutscher Ing—Jan. 2, 9, 16, 1897. No. 10,757. 60 cts.

SHIPBUILDING and Marine Engineering in 1896. (Review of the year, dealing with separate districts. Part 1st reports the Tyne, Wear, Tees, Hartlepool, Blythe and Whitby, Humber, Barrow-in-Furness, Mersey, Thames and other districts. 5,500 w.) Engng—Jan. 1, 1897. Serial, 1st part. No. 10,399. 30 cts.

SHIPBPILDING, Recent Advances in. (Review of progress in this industry. Ill. 1,700 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,963. 30 cts.

SPONTANEOUS Ignition of Coal Cargoes, The. Vivian B. Lewes (Results of a long series of experiments throwing some light on the cause of this class of phenomena, with suggestions for prevention. 6,000 w.) Pro Age—Jan. 15, 1897. No. 10,484. 15 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER-ROOM Labor, The Cost of (Information concerning the cost of labor in steam-boiler plants, taken from Circular No. 6 of the Steam Users' Assn. 700 w.) Eng News—Jan. 28, 1897. No. 10,662. 15 cts.

BOILER Progress. See same title under Architecture, Heating and Ventilation.

BUTT JOINT, A Form of Quadruple-Riveted (Illustrated description, with consideration of advantage and calculation of strength. 3,000 w.) Sta Eng—Feb., 1897. No. 10,932. 15 cts.

CHEMISTRY in the Boiler-Room. William Thompson (Shows the actual need of at least a rudimentary chemical education, and follows with a discussion of the reactions constantly taking place during combustion. 1,400 w.) Can Elec News—Jan., 1897. Serial. 1st part. No. 10,359. 15 cts.

CONDUCTION in Steam Boilers, Heat. Herbert G. Geer (A discussion of the conditions on which the amount of heat conducted from one point to another depends. 1,800 w.) Power—Feb., 1897. No. 10,873. 15 cts.

EFFICIENCY and Management of Steam Boilers. E. J. Duff (Read at meeting of Manchester Assn. of Engs. Considers some of the causes which contribute to the loss of efficiency in boilers. 4.500 w.) Col Guard—Jan. 29, 1897. No. 10,954. 30 cts.

FEED-HEATER System, A New. Karl Lurdkvist (Illustrated description of trials carried out with the writer's feed-heater system, which is constructed on the principle of using both the latent and sensible heat of the steam for a more intense heating up of feed-water. 2,500 w.) Engng—Jan. 29, 1897. Serial. 1st part. No. 10,947. 30 cts.

MAN-HOLE Openings. From The Locomotive (Rules for their proper reinforcement. 1,500 w.) Bos Jour of Com—Jan. 23, 1897. No. 10,572. 15 cts.

SAFETY VALVES (Soupapes de Sureté) (Illustrated description of the Génard safety valve, an improvement on the "pop" type. 3,000 w.) La Revue Technique—Jan. 10, 1897. No. 10,772. 30 cts.

SCALE, Feed Water and Boiler (Injurious effects of scale, and its removal. 1,600 w.) Bos Jour of Com—Jan. 23, 1897. No. 10,573. 15 cts.

STACKS, A Story of. Robert Kuntsman (Considers the functions of the chimney as a means to effect economic combustion, as a conveyor of surplus products and gases, and its construction in brick or iron. 3,500 w.) St Ry Rev—Jan. 15, 1897. Serial. 1st part. No. 10,523. 30 cts.

STOKING, The Advantages of Mechanical. A. E. Outerbridge, Jr. (Historical and general comparison of mechanical stoking and hand firing, proving the practicability of complete smoke-combustion. Ill. 3,500 w.) Eng Mag—Feb., 1897. No. 10,301. 30 cts.

WATER-TUBE Boiler Construction (Illustrated description of design and construction. 1,200 w.) Mech Wld—Jan. 29, 1897. Serial. 1st part. No. 10,939. 30 cts.

WATER TUBE Boilers, A Trio of One Thousand Horse-Power (Illustrated description of the giant water tube boilers erected at the new station of the New York Steam Co. 900 w.) Sci Am—Jan. 30, 1897. No. 10,654. 15 cts.

WATER TUBE Boilers Over Other Types, Superiority of. George Shaw (Read before the Columbia Assn. of Stationary Engs. Sums up the points of superiority claimed for the water tube boiler, and discusses each point briefly. 3,000 w.) Am Mfr & Ir Wld—Jan. 22, 1897. No. 10,625. 15 cts.

WATER TUBE Boiler. See also same title under Marine Engineering, Boilers and Engines.

COMPRESSED AIR.

BELT DRIVEN Air Compressor, Richards's Automatic. (Illustrated description of a compresser designed especially for shop use or for any place where there is running shafting and where it is desirable to maintain a constant supply of compressed air without care of apparatus and at the least cost. 300 w.) Am Mach—Jan. 14, 1897. No. 10,429. 15 cts.

COMPRESSED AIR. Henry T. Hulst (Noting its increased use and diverse application. 1,600 W.) Yale Sci M—Jan., 1897. No. 10,531. 30 cts.

MINES, Use of Compressed Air in. M. Mortier (From a communication to the Societe de l'Industrie Minerale, Saint-Etienne. A review of the question whether compressed air has been turned to its fullest account as regards useful effect, or whether variations may be introduced with advantage into the method of its utilization. A summing up of the principles of this branch of mechanics. 4,000 w.) Col Guard—Jan. 22, 1897. No. 10,711. 30 cts.

MOTOR on the Elevated Railroads, New York, Compressed Air (Illustrated description of the experimental motor soon to be placed on the elevated roads, with comments and explanation of system. 1,300 w.) Sci Am—Jan. 30, 1897. No. 10,655. 15 cts.

PUMPING with the Pohle Air-Lift, Some Figures on the Cost of. George R. Murray (The cost under the system is discussed in detail, both for large and small plants. 2,200 w.) Compressed Air—Jan., 1897. No. 10,504. 15 cts.

RAILROAD SHOPS, Compressed Air in. J. J. Flather (Extracts from paper presented before the Western Ry. Club. The adaptation of compressed air to various requirements. 1,800 w.) R R Gaz—Jan. 22, 1897. No. 10,564. 15 cts.

REFRIGERATION, Compressed Air. Frank Richards (Describes, with comment, a plant employing compressed air for refrigeration. 1,200 w.) Am Mach—Jan. 21, 1897. No. 10,553. 15 cts.

SHOPS of the Atchison, Topeka and Santa Fe, Compressed Air at the (Illustrated description of the plant. 1,500 w.) R R Gaz—Jan. 15, 1897. Serial. 1st part. No. 10,460. 15 cts.

TRANSMITTING Power, Advantages of Compressed Air for. J. W. Pearse (Extracts and conclusions from a paper to the Societe de l'Industrie Minerale of France, by M. Mortier, who has made a critical study of the subject. 1,500 w.)

Compressed Air—Jan., 1897. No. 10,503. 15 cts.

USE of Compressed Air on a Great Work (Describes the service to which this power is put in the construction of the Jerome Park Reservoir for the water supply of New York City. 1,500 w.) Mfrs Record—Jan. 15, 1897. No. 10,483. 15 cts.

USES of Compressed Air, Some of the (Discussion at the Western Railway Club, December meeting, of Mr. McConnell's paper read at the Nov. meeting. 6,500 w.) R R Gaz—Jan. 15, 1897. No. 10,461. 15 cts.

ENGINES AND MOTORS.

CRANK SHAFTS, Speed Variations in. George P. Starkweather (Gives a method of discussing engine dynamics which is quite exact. 1,500 w.) Jour Fr Inst—Feb., 1897. No. 10,919. 45 cts.

ELECTRIC Lighting by Gas Engine, Cost of. See Gas Engine under Electrical Engineering, Lighting.

EXPERIMENTAL Engines at the Durham College of Science, Newcastle-upon Tyne, with Some Results from Same, The. R. I. Weighton (Part first comprises a description of the engines and their accessories, with illustrations; also editorial. 4,500 w.) Eng Lond—Jan. 22, 1897. Serial, first part. No. 10,709. 30 cts.

GAS and Oil Engines. Thomas L. Wilkinson (A review of the growth of the gas and oil engine industry, with brief history and testimony as to their efficiency and economy. 3,300 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,374. 15 cts.

GAS ENGINE, Experiments on a 160-h. p.—Driven with Producer Gas at the Bale Water Works, Switzerland, 1896 (Summarized translation, by Bryan Donkin. The trials are of value in proof that a gas engine will work well and economically on producer gas from gas-works coke. Original in Zeitscshr. des Ver. Deutsch. Ing. 2,500 w.) Jour Gas Lgt—Jan. 5, 1897. No. 10,446. 30 cts.

GAS ENGINES, Gas and Petroleum Motors at the Geneva and Berlin Exhibitions of 1896 (Die Gas und die Petroleummotoren auf der schweizerischen Landesausstellung in Genf, 1896 und auf der Berliner Gewerbeausstelling, 1896.) (With description of improvements in igniting, governing and efficiency. 8,000 w.) Zeitschr. d. Vereines Deutsch. Ing—Jan. 2, 1897. No. 10,759. 20 cts.

HIGH-PRESSURE Steam, The Promise and Potency of. R. H. Thurston (Read at N. Y. meeting of the A. S. M. E. in Dec., 1896. A study of high-pressure steam in the saturated state. The facts are in part deduced from a triple-expansion and a quadruple-expansion high-pressure engine used experimentally at Sibley College. 3,000 w.) Ind & Ir—Jan. 8, 1897. Serial, part first. No. 10,505. 30 cts.

INDICATOR, The Steam Engine (The faulty points. A series of cards is given to show some of the incorrect positions and to illustrate remarks upon the remedies to be applied. 1,700 w.) Am Elect'n—Jan., 1897. No. 10,548. 15 cts.

PUMPING Engines, Brighton Water Works (Brief illustrated description of a triple-expansion pumping engine. 900 w.) Eng Lond—Jan. 22, 1897. No. 10,708. 30 cts.

SEPARATOR, The Steam (Some of its advantages and where it should be placed. 1,200 w.) Bos Jour of Com—Feb. 6, 1897. No. 10,931. 15 cts.

SHORT-STROKE Steam Engines. J. S. Raworth (Read before the Yorkshire College Engng. Soc. Explains the construction and development of what has been named "high-speed" steam engines; considers the principles involved in engines suitable for driving machines which run at a high speed of rotation, such as dynamos, fans, centrifugal pumps, &c. 3,800 w.) Engng—Jan. 29, 1897. No. 10,949. 30 cts.

STEAM ENGINE Development (Traces the great improvements that have been made and the development from low-pressure single cylinders to the high-pressure compound. 1,300 w.) Bos Jour of Com—Feb. 6, 1897. No. 10,930. 15 cts.

POWER AND TRANSMISSION.

COMPRESSED AIR. See title "Transmitting," under Mechanical Engineering, Compressed Air.

DISTRIBUTION of Power in Workshops. See same title under Electrical Engineering, Power.

ELECTRICAL Transmission. See titles "Economics" and "Transmission," under Electrical Engineering, Power.

"FRICTION Horse Power in Factories." Samuel Webber (Notes called forth by Mr. Benjamin's paper on same subject. 1,300 w.) Mach—Feb., 1897. No. 10,865. 15 cts.

GEARING, The Limiting Velocity in Belt and Rope. George R. Bale (The proposition is stated and demonstrated. 800 w.) Prac Eng—Jan. 29, 1897. No. 10,953. 30 cts.

ROPE DRIVING Practice, European. P. M. E. (Notes in European practice in transmitting power by fibrous ropes. 1,900 w.) Power—Feb., 1897. No. 10.875. 15 cts.

SHAFTING Tables. (Tables calculated by Hans Birkholz, with explanation. 1,000 w.) Power—Feb., 1897. No. 10874. 15 cts.

WATER Under Pressure for Transmitting Power, The Use of. M. Martin (Letter to the Société de l' Industrie Minérale. Presents the advantages and defects of the deviation system, and a system almost exempt from these disadvantages. 1,300 w.) Col Guard—Jan. 8, 1897. No. 10,507. 30 cts.

SHOP AND FOUNDRY.

ALUMINUM Bronze Machinery Bearings, Experiments with. George D. Rice (Illustrated description of some practical experiments made with these bearings. 1,200 w.) Ir Age—Jan. 21, 1897. No. 10,542. 15 cts.

ANCHOR-BOLT, Repairing an. Charles A. Hague (Describes a difficult piece of work in repairing an anchor-bolt which had broken about 40 inches below the upper nut. 900 w.) Am Mach—Jan. 21, 1897. No. 10,551. 15 cts.

BALANCING Armature and Other Rotating Parts of Machinery. William Baxter, Jr. (Describes and illustrates apparatus devised by the writer to obtain greater accuracy in the balancing of armatures and also to reduce the cost of operation. 1,400 w.) Am Mach—Feb. 4, 1897. No. 10,877. 15 cts.

BELT PULLEY Made Entirely of Wrought Steel, A (Illustrated description. 500 w.) Eng News—Feb. 4, 1897. No. 10,899. 15 cts.

BENDING Drawbar Yokes, Machine for (Illustrated description. 400 w.) Loc Engng—Feb., 1897. No. 10,891. 30 cts.

CHILLED Iron; Transverse Strength of —as Affected by the Relative Directions of Stress and Chill. Asa W. Whitney (Read at meeting of Foundrymen's Assn. Summary of tests, with comparison and explanation. 2,000 w.) Ir Tr Rev—Jan. 14, 1897. No. 10,492. 15 cts.

COVERING MACHINES for Wires and Cables. V. B. (Discusses the various methods of covering and the merits of different machines. 1,100 w.) Ind Rub Wld—Feb. 10, 1897. No. 10,966. 45 cts.

D-DRILLS and Wood Reamers. John Randol (Illustrated description of tools which have almost disappeared from modern machine shops, but have acquired great importance in the production of built-up guns. 2,300 w.) Am Mach—Jan. 14, 1897. No. 10,431. 15 cts.

ELECTRICAL Machinery, Repairs of. A. R. Harris (Illustrated directions designed to make ordinary repairs of this character possible to a man of ordinary intelligence. 1,700 w.) Am Mach—Jan 14, 1897. Serial. 1st part. No. 10,430. 15 cts.

ELECTRICAL Machinery, The Mechanical Construction of. F. M. Weymouth (A consideration of some of the principles involved in the mechanical construction of a dynamo. Part 1 commences with the bedplate. 2,200 w.) Elec Eng, Lond—Jan. 1, 1897. No. 10,394. 30 cts.

FOUNDRY Practice, Niles Tool Works. Peter J. Connor (Brief illustrated description of methods. 600 w.) Mach—Feb., 1897. No. 10,863. 15 cts.

HAMMER, Notes on the. Herbert Aughtie (Enumerates and explains the principles of its action. 1,300 w.) Prac Eng —Jan. 15, 1897. No. 10,618. 30 cts.

IRON, Freaks of Foundry—Dr. A. B. Harrison (Read at meeting of W. Penna. Central Min. Inst. Some analysis of foundry iron and a series of physical tests. 1,800 w.) Am Mfr & Ir Wld—Jan. 8, 1897. No. 10,386. 15 cts.

LIGHTING the Shop. Herbert Pratt (General suggestions aiming to aid in deciding the advisability of putting in a plant for one's own electric lighting. 1,500 w.) Mach—Feb., 1897. No. 10,864. 15 cts.

MACHINE TOOLS. The Machine Tools at the Fourth Cycle Salon (Les Machines-Outils au quatriéme Salon du Cycle). An illustrated description of bicycle tools, mostly of American design. 2,500 w.) La Revue Technique—Dec. 25, 1896. No. 10,765. 30 cts.

MOULDING and Gating Steel Castings. George O. Vair (Sketches showing the dissimilarity between iron and steel moulding. 1,000 w.) Am Mach—Jan. 14, 1897. No. 10,428. 15 cts.

MIXTURES, Regulating Foundry. Thomas D. West (Read at meeting of Pittsburg Foundrymen's Assn. Information on this subject, claiming that silicon and sulphur are the cause of the difference in grades of iron. 1,300 w.) Ir Tr Rev—Jan. 28, 1897. No. 10,694. 15 cts.

PIECE-WORK vs. Day's Work. Robert Grimshaw (Shows that what might be best for one shop or set of men might prove a failure under different circumstances. 1,400 w.) RR Car Jour—Jan., 1897. No. 10,358. 15 cts.

PLANING Jobs, Special. John Randol (Shop-work with the planer is described, with illustrations of different makes of planers and explanations. 2,000 w.) Am Mach—Jan. 28, 1897. No. 10,652. 15 cts.

REAMER, Chattering. Frank Richards (A talk about reamers and the ways of curing "chattering." 1,200 w.) Am Mach—Jan. 28, 1897. No. 10,653. 15 cts.

SHOP MANAGEMENT, Six Examples of Successful. Henry Roland (Describing the piece-rate systems in use by the Baldwin Locomotive Works, the Midvale Steel Co., and William Sellers & Co. 3,400 w.) Eng Mag—Feb., 1897. No. 10,303. 30 cts.

TOOLS, Some American Machine (Illustrations and descriptions of machines built by the Newton Machine Tool Works of Philadelphia. 2,000 w.) Eng, Lond—Jan. 15, 1897. No. 10,590. 30 cts.

WHEELS, Machine-Moulded. Joseph Horner (In this series of articles it is proposed to illustrate and explain the details in the pattern and foundry work involved in wheel moulding, in their relation and application to the numerous and varied classes of gears in common use, including spur and bevel, mortise, helical, worm and angle wheels. Also different methods of moulding and their modifications. 4,700 w.) Engng—Jan. 15, 1897. Serial. 1st part. No. 10,580. 30 cts.

MISCELLANY.

AUTOMOBILISM, The Future of—in the Army (L'Avenir de l'Automobilisme dans l'Armeé) The first article of a serial discussing the influence of improvements in transportation upon military manoeuvres. 3,500 w.) La Revue Technique—Jan. 10, 1897. No. 10,782. 30 cts.

BICYCLES, Changes of Speed for. E. Hospitalier (A study of gears, examining the principal solutions of the problem so far as they have received practical sanction. 1,500 w.) Sci Am—Jan. 16, 1897. No. 10,437. 15 cts.

CAPILLARY TUBES, Viscous Flow in. R. M. Deeley and C. E. Wolff (Mathematical investigation of values in mechanics. 2,200 w.) Eng, Lond—Jan. 1, 1897. No. 10,404. 30 cts.

CHIPS, The Making of. Tecumseh Swift (Suggests a line of investigation of metals. 1,600 w.) Am Mach—Feb. 4, 1897. No. 10,878. 15 cts.

COOKING BY STEAM. The Egrot Steam Cooking Apparatus. (Les Cuisines a Vapeur Egrot.) (An illustrated description of the steam cooking apparatus used in many of the large hotels and institutions of Paris. 2,500 w.) La Revue Technique—Jan. 10, 1897. No. 10,773. 30 cts.

DRAFTING ROOM, The Decimal Index in the. H. W. Alden (Describes a system providing a simple and ready reference for drawing, and a logical pattern number which indicates the use for which the pattern was intended. 2,000 w.) Am Mach—Feb. 4, 1897. No. 10,879. 15 cts.

DYNAMOMETER, A Hydraulic (Illustrated description of a machine constructed by Prof. James D. Hoffman, of Purdue University, and of tests made with it. 1,500 w.) RR Gaz—Jan. 22, 1897. No. 10,563. 15 cts.

ELEVATOR, Duckham's Pneumatic Grain (Illustrated description of system in use on the Danube. 1,000 w.) Engng—Jan. 29,1897. No. 10,946. 30 cts.

ENERGY in Motor Cars, Storage of (Abstract of lecture by M. Marcel Desprez at the Automobile Club de France, with comments. 1,500 w.) Eng, Lond—Jan. 15, 1897. No. 10,591. 30 cts.

GOVERNOR for Electrical Work. See same title under Electrical Engineering, Miscellany.

GRAIN ELEVATOR. Travelling Elevator for Unloading Vessels. (Fahrbarer Schiffs-Elevator. (Description and illustration of elevators as arranged in Buda-pest, to travel on tracks along the quay. 2,000 w.) Zeitschr d Oesterr Ing u Arch Vereines—Jan. 1, 1897. No. 10,752. 15 cts.

GROOVED PLATES, The Strength of. C. E. Wolff (Shows what the results would be in the case of a perfectly elastic and a perfectly ductile plate respectively. 550 w.) Prac. Eng—Jan. 29, 1897. No. 10,952. 30 cts.

INTEGRAL CURVES. W. F. Durand (A brief presentation of the more important properties. 3,000 w.) Sibley Jour of Engng—Jan., 1897. No. 10,636. 30 cts.

INDICATOR Springs, New Method of Testing (Illustrated description. 1,100 w.) Power—Feb., 1897. No. 10,876. 15 cts.

MECHANICAL Engineering (Review ot the year in Great Britain; reports the interest to have centred in the Belleville boiler and the motor car. The article is largely confined to the prospects of the motor car and review of locomotive and marine engineering progress. 4,000 w.) Eng, Lond—Jan. 1, 1897. No. 10,407. 30 cts.

REFRIGERATION. The Production of Cold. (Kälteerzeugung.) Two articles by Dr. H. Lorenz upon refrigerating machinery, treating of the theory as well as mechanical details. 10,000 w.) Zeitschr Ver Deutscher Ing—Jan. 9, 1897. No. 10,761. 40 cents.

SMOKE-WASHING Device, An Interesting (Description, with plan and elevation of the economizer, mechanical draft and smoke-washing plant recently added to the equipment of station J of the N. Y. Steam Co., located near the corner of Fifty-ninth street and Madison ave., New York. 700 w.) Eng Rec—Feb. 6, 1897. No. 10,926. 15 cts.

TESTS, The Error of Comparative. W. H. Booth (Advising Engineers to be on their guard against reasoning based on comparisons, and showing that the conclusions drawn are often incorrect. 1,500 w.) Am Mach—Jan. 21, 1897. No. 10,552. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

ACCIDENTS, Safeguards Against Danger from Gases and Falls of Coal and Roof. William Jenkins (Read at meeting of W. Penna. Central Min. Inst. Points and some safeguards as they appear to the writer. 3,000 w.) Am Mfg and Ir Wld—Jan. 15, 1897. No. 10,491. 15 cts.

CALORIFIC Power of Coal, The Determination of the. W. Nayes, M. Tuggart and W. Craver (Comparison of results obtained by the Hempel Calorimeter with those obtained from analysis and by the Berthier method. 1,300 w.) Pro Age—Jan. 15, 1897. No. 10,486. 15 cts.

COAL-CUTTING Machinery. Cyrus Robinson (Reviews papers of Messrs. Gould and Hanford and shows that system to be best which best fits the conditions. 1,200 w.) Am Mfr & Ir Wld—Jan. 22, 1897. No. 10,628. 15 cts.

COAL Trade in 1896, The (Review of the year in different districts. 8,000 w.) Col Guard—Jan. 1, 1897. No. 10,413. 30 cts.

CONSTITUENTS of Coal, The Proximate (Results of investigations by a committee of the British Association. 2,500 w.) Jour of Gas Lgt—Jan. 5, 1897. No. 10,447. 30 cts.

EXPLOSIONS, Coal Dust and Colliery (Epitome of a paper entitled "The Rationale of Colliery Explosions from Coal Dust," read by Donald M. D. Stuart before the Bristol Assn. of Engrs. 1,700 w.) Jour Gas Lgt—Dec. 29, 1896. No. 10,343. 30 cts.

ECONOMICS of Coal Mining, The. Henry Louis (States the economic problem of the coal trade in England and reviews available data. 3,300 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,694. 30 cts.

EQUIPMENT of Collieries, The Engineering (Calls attention to the number of industries engaged in providing for the engineering equipment. 1,000 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,961. 30 cts.

EXPLOSIVES in Coal Mining (An examination of the new order issued by the Home Secretary with reference to the explosives to be used in coal mines. 2,500 w.) Min Jour—Jan. 16, 1897. Serial, first part. No. 10,594. 30 cts.

EXPLOSIVES in Belgian Collieries, The Use of. Victor Watteyne (From an official report. Gives table showing intensity of blasting for driving roads during three years in the non-fiery and the three classes of fiery mines; also the new regulations and the motive that led to their adoption. 1,800 w.) Col Guard—Jan. 29, 1897. No. 10,955. 30 cts.

GASES of the Coal Mine, Some Dangerous (Abstract of a lecture by F. Clowes. Consideration of some of the common "damps" or gases which cause danger in the coal mine, such as fire-damp, choke-damp and black-damp. 1,800 w.) Min Jour—Jan. 2, 1897. No. 10,363. 30 cts.

GERMANY, The Coal Industry of—in 1896 (Review of economic conditions, production, &c. 1,000 w.) Ir & Coal Tr Rev —Jan. 1, 1897. No. 10,365. 30 cts.

HAULING Machinery, The Improvement of. Reuben Street (Read at meeting of the W. Penna. Central Min Inst. Notices the system of rope haulage, compressed air and electricity as they appear in general use. 2,600 w.) Am Mfr & Ir Wld—Jan. 8, 1897. No. 10,388. 15 cts.

LIMIT to the Output of a Coal Mine? Is There an Economic. William Blackmore (Read at meeting of the Min. Soc. of Nova Scotia. The subject is discussed and suggestions indicated which seem to have a bearing upon the decision in respect to every mine. 2,500 w.) Can Min Rev—Jan., 1897. No. 10,725. 30 cts.

POWER PURPOSES in Coal Working, On the Comparative Advantages and Disadvantages of Steam, Compressed Air and Electricity for—with Special Reference to Coal-Cutting and Haulage. G. E. J. McMurtrie (After extended consideration the writer's conclusions favor electricity. 7,500 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,958. 30 cts.

SAFETY LAMP, The First. William Clifford (History of its invention and the controversy between Davy and Stephenson. Reviews events which incited scientists and philanthropists to seek a safe light for fiery mines, and traces the evolution of the Davy lamps. Read before the W. Penna. Cent. Min. Inst. 4,000 w.) Col Eng—Jan., 1897. No. 10,474. 30 cts.

THIN SEAMS, Is it Profitable to Mine—of Coal by Any of the Types of Electrical Mining Machines Now in Use? (Giving the advantages of a compressed-air plant and claiming good results. 1,000 w.) Am Mfr & Ir Wld—Jan. 8, 1897. No. 10,387. 15 cts.

WORKING of Coal in Scotland, Past and Present. James Barrowman (Historical account. 3,000 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,959. 30 cts.

COPPER.

COPPER MATTE Blast-Furnace Charges, The Calculation of. H. Van F. Furman (The paper has been written more for the student than for the practical metallurgist. The most important points which must be considered are stated and the calculations illustrated by examples. 3,000 w.) Sch of Mines Quar—Nov., 1896. No. 10,934. 45 cts.

NEVADA, The Copper Mines of. Dan de Quille (Brief review of what has been done in mining copper in this State, which is said to be rich in this metal. 1,800 w.) Min & Sci Pr—Jan. 23, 1897. No. 10,656. 15 cts.

NICKEL and Copper in Matte and the Recovery of the Contained Precious Metals, The Separation of. Titus Ulke (A review of the various electrolytic methods proposed. 3,300 w.) Eng & Min Jour—Jan. 30, 1897. No. 10,676. 15 cts.

GOLD AND SILVER.

AUSTRALIA, Exploration in West and South. W. Carr Boyd (Illustrated condensed account of a twelve months' exploring trip for the purpose of discovering auriferous country. 2,400 w.) Aust Min Stnd—Nov. 26, 1896. Serial. 1st part. No. 10,421. 30 cts.

BROMO-CYANIDE Process of Treatment of Gold Ores and Tailings, The (Present advantages over the ordinary cyanide process. 1,400 w.) Aust Min Stnd—Dec. 3, 1896. No. 10,422. 30 cts.

BURMA, Notes Upon Gold Mining in. A. H. Bromly (Abstract from a paper read before the Federated Inst. of Min. Engs. Distribution and mode of occurrence of the metal, with manner of working. 1,600 w.) Min Jour—Jan. 16, 1897. No. 10,593. 30 cts.

CYANIDE Process for the Treatment of Gold Ores, The. Joseph W. Richards (The story of the rise of the commercial cyanide process is briefly told, the patented basis examined, improvements made and needed, and conditions for successful use. 4,800 w.) Jour Fr Inst—Feb., 1897. No. 10,917. 45 cts.

CYANIDE Solutions, Solvent Power of Various. A. F. Crosse (From the South African Mining Journal. Describes experiments which will prove interesting to those practically engaged in the cyanide process of gold recovery. 3,400 w.) Min Jour—Jan. 23, 1897. No. 10,719. 30 cts.

CYANIDING, Some Problems in. C. C. Longridge (Some results of experimental work undertaken to effect improvements and secure economy. 1,500 w.) Min Jour—Jan. 23, 1897. No. 10,717. 30 cts.

CRIPPLE CREEK Mining District During 1896. Charles J. Moore (Review of the year, showing a steady advance both in the quantity of ore and number of mines opened. 2,800 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,381. 15 cts.

CRIPPLE CREEK Practices, Some. Wascott (Information in reference to the milling capacity, leasing system and tunnel enterprises. 1,300 w.) Min & Sci Pr—Jan. 2, 1897. No. 10,338. 15 cts.

GOLDSMITHS' Trade Related to Wealth. See same title under Economics and Industry, Miscellany.

GOLD STEALING in the Siberian Placers. E. D. Levat (An account of the habits of theft and the system of work. 700 w.) Eng & Min Jour—Feb. 6, 1897. No. 10,913. 15 cts.

MATTE, Granulating. S. E. Brotherton (A brief article showing the advantages of granulating matte and how it is done at the American Smelter in Leadville, Col. 400 w.) Eng & Min Jour—Jan. 9, 1897. No. 10,308. 15 cts.

ORE REDUCTION in Colorado, Progress and Present Status of Methods of. H. Van F. Furman (Each metal is considered separately and the progress made is briefly traced. 3,300 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,373. 15 cts.

PELATAN-CLERICI Process at De Lamar, The (From the De Lamar Nugget. Description of the operation of this process. The theory of the treatment is the solution of the bullion in the pulp by the use of cyanide and then recovering the values by electricity. 800 w.) Min Ind & Rev—Jan. 28, 1897. No. 10,887. 15 cts.

PRECIOUS Metals, The (An estimate of the quantity in use in the world at various times, with suggestions as to what becomes of it and the use in manufactures and arts. 3,300 w.) Min Ind & Rev —Dec. 31, 1896. No. 10,375. 15 cts.

PRODUCTION, Present and Future, Gold (Statistics show that a point has been reached in excess of any ever before attained, The causes affecting production are considered with especial reference to future probabilities. 2,000 w.) Eng & Min Jour—Jan. 9, 1897. No. 10,306. 15 cts.

REFRACTORY Low-Grade Gold Ores at the Ouro Preto Gold Mine, Brazil, Notes on the Treatment of. S. G. McCormick (Part first describes the former treatment of the ore and the present method of working, with the special local conditions. 3,000 w.) Min Jour—Jan. 23, 1897. Serial. 1st part. No. 10,715. 30 cts.

SAN MIGUEL County, Resources of. Theo. F. Van Wagenen (Interesting description of the country, deposits, value, transportation facilities, etc. 1,800 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,376. 15 cts.

SIBERIA, The Gold Placers of. E. D. Levat (The characteristics of the gold formations described, with conjecture as to their probable origin. 1,500 w.) Eng & Min Jour—Jan. 23, 1897. No. 10,559. 15 cts.

SILESIA, Gold in (Gold in Schlesien) (A discussion of the geological conditions under which gold is found in Silesia, and a comparison with those of California. 4,000 w.) Glaser's Annalen—Jan. 15, 1897. No. 10,783. 15 cts.

STAMP MILL Practices, Certain. James W. Abbott (Some details of the work. 1,400 w.) Min & Sci Pr—Jan. 2, 1897. No. 10,339. 15 cts.

TREATMENT of the Gold Ores of the Guanaco Mineral District, Desert of Atacama, Chili, Notes on the. G. M. Barber (Brief account of the difficulties encountered and the irregular and singular occurrence of the gold, with partial description of the treatment of the ore. 2,300 w.) Min Jour—Jan. 23, 1897. Serial. 1st part. No. 10,718. 30 cts.

IRON AND STEEL.

ARMOR PLATE, The Cost of American (Editorial Review of the report of Secy. Herbert and of that of Secy. Whitney in 1886, with comment. 1,500 w.) Eng News —Jan. 14, 1897. No. 10,454. 15 cts.

CARBON Content, Effect of—on the Endurance of Steel. H. K. Landis (It is shown that an increase of carbon content has a marked effect in increasing the strength and raising the elastic limit. Tables compiled from reports for 1888, 1889 and 1894. 700 w.) Ir Tr Rev—Jan. 7, 1897. No. 10,361. 15 cts.

ELASTIC LIMIT or Yield Point? P. Kreuzpointner (The meaning of elastic limit is discussed; subsequent parts will give a study of the elasticity of steel. 2,800 w.) Ir Age—Jan. 21, 1897. Serial. 1st part. No. 10,541. 15 cts.

"FLOW" in Rolling of Steel. William Cuthill (Read before the West of Scotland Iron and Steel Inst. The operation of rolling is considered in relation to the experiments of M. Tresca upon the "flow" of solids, and the three points of speed of bar, diameter of rolls and depth of draft are studied in reference to economy of driving power of the mill. 2,200 w.)Col Guard—Jan. 22, 1897. No. 10,713. 30 cts.

FORGINGS, Steel. H. F. J. Porter (Illustrated historical review of the development of the art of forging in this country and of the circumstance leading to the erection of the Bethlehem Iron Co.'s plant; describes the processes in use there. 8,400 w.) Jour W Soc of Engs—Dec., 1896. No. 10,470. 45 cts.

HEMATITES of Alabama Geologically Considered, The. Henry McCalley (The more important ones are of Silurian formation; they are described, with statement of the advantages which have led to their remarkable development. An approximate general section of East Red Mountain, between Birmingham and Bessemer, is given. 2,000 w.) Eng & Min Jour—Jan. 9, 1897. No. 10,309. 15 cts.

IRON METHODS, Notes on Some Comparisons Between Southern and Nova Scotia. C. A. Meissner (A comparison of conditions, with special reference to price and quality. 5,500 w.) Can Min Rev—Jan., 1897. No. 10,724. 30 cts.

JAPAN, Experiments in Steel-Making in (Briefly notes the experiments, results and considerations entertained by the Japanese Government preparatory to starting a steel-making establishment. 1,800 w.) Engng—Jan. 8, 1897. No. 10,502. 30 cts.

LAKE SUPERIOR Iron Mines (Facts relating to these mines, with supplement giving the shipments for 1896 and the past forty-one years. 1,200 w.) Ir Tr Rev —Jan. 21, 1897. No. 10,619. 15 cts.

MINNESOTA Iron Mines in 1896. Horace V. Winchell (An explanation of Mesaba Range problems and their solution, and of the three methods adopted for mining these flat deposits, with a statement of the conditions for the immediate future. 2,000 w.) Ir Tr Rev—Jan. 7, 1897. No. 10,360. 15 cts.

NICKEL STEEL in Metallurgy, Mechanics and Armor. Henry W. Raymond (Reviewing the events that led up to the congressional appropriation of one million dollars for the purchase of nickel ore. 3,600 w.) Eng Mag—Feb., 1897. No. 10,304. 30 cts.

OPEN-HEARTH Steelmaking, Twelve Months' Progress in. Bernard Dawson (Review of advances made in the past year, most of which have come from the chemists rather than the engineers. 2,600 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,960. 30 cts.

PHOSPHORUS in Steels, On the Influence of Heat Treatment and Carbon Upon the Solubility of. E. D. Campbell and S. C. Babcock (Contribution to the Am. Chem. Jour. from the Laboratory of Analytical Chemistry of the University of Michigan. Research undertaken to determine whether chemical evidence could be obtained to prove that phosphorus may exist in steel in at least two forms. 1,100 w.) Am Mfr & Ir Wld—Jan. 22, 1897. No. 10,626. 15 cts.

PIG-IRON as a Possible Secondary Product of the Blast-Furnace. B. H. Thwaite (Calls attention to improvements aiming to increase the power-supply, profit-earning capacities of the furnace, to an extent that will make the question of iron-making an indifferent essential. 1,500 w.) Ir & Coal Trds Rev—Jan. 29, 1897. No. 10,962. 30 cts.

PIG-IRON, Southern. See same title under Economics and Industry, Commerce and Trade.

PLATE Mills, The Bethlehem (Illustrated detailed description. 1,800 w.) Ir Age—Jan. 21, 1897. No. 10,540. 15 cts.

PRICES in 1895 and 1896, Iron and Steel (Diagram showing the course of prices in the iron and steel business during the last two years, with review of the period. 500 w.) Eng News—Jan. 14, 1897. No. 10,451. 15 cts.

PYROMETER in the Down Comer, The Value of the. Edward A. Uehling (Calls attention to the fact that an accurate record of the temperature of the waste gas of the blast-furnace is a reliable indicator of what is going on inside the furnace and of what was done in the stock-house toward keeping the furnace properly filled. 2,500 w.) Am Mfr & Ir Wld—Jan. 22, 1897. No. 10,624. 15 cts.

RAILS and Tires, Micro-Mechanical Examination of Old Steel. J. E. Stead (Paper presented to the West of Scotland Iron and Steel Inst. Results from the examination of a large number of old steel rails. 1,400 w.) Ind & Ir—Jan. 15, 1897. Serial. 1st part. No. 10,592. 30 cts.

SOUTH, and How They Are Being Developed, The Iron Mines of the. Frank G. Carpenter (Historical review of the iron industry of this country, especially in the south. 3,500 w.) Tradesman—Jan. 15, 1897. No. 10,514. 15 cts.

STRUCTURAL STEEL, Some Open Questions Concerning. Topical discussion (Six short papers on special topics, and a general discussion are given. The contributors are H. H. Campbell, Albert Ladd Colby, Frederick H. Lewis, James Christie, G. C. Henning and P. Kreuzpointner. Ill. 15,000 w.) Pro of Engs' Club of Phila—Jan., 1897. No. 10,968. 45 cts.

SULPHUR in Iron. S. S. Knight (Some remarks on the harmful results of too large quantities of sulphur. 1,200 w.) Foundry—Jan., 1897. No. 10,617. 15 cts.

TESTING of Iron and Steel, Standardizing the. P. Kreuzpointner (Showing that a test piece should be as large as practicable and geometrically proportionate. Ill. 4,800 w.) Eng Mag—Feb., 1897. No. 10,-296. 30 cts.

MINING.

BLUE HEAT. (Ueber Blauwärme) (Investigating the behavior of iron at a blue heat under various tests. 7,500 w.) Glaser's Annalen—Jan. 15, 1897. No. 10,784. 15 cts.

BRITISH COLUMBIA, Notes on Some of the Mining Districts of. William Hamilton Merritt (Reports of various camps and general information showing the promise of development of mineral wealth. 1,700 w.) Eng & Min Jour—Jan. 16, 1897. No. 10,494. 15 cts.

CAGES with Movable Floor, Falling Stop Arrangement for Winding (Illustrated description, with explanation of method of working. 2,000 w.) Col Guard Jan. 1, 1897. No. 10,414. 30 cts.

COMPRESSED AIR. See title "Mines" under Mechanical Engineering, Compressed Air.

DRAINAGE of American Flat, The. Dan de Quille (Describes the location and existing conditions of American flats and the proposed extension of the Sutro drain tunnel. 1,500 w.) Min & Sci Pr—Jan. 30, 1897. Serial. 1st part. No. 10,871. 15 cts.

ELECTRICAL firing in Fiery Mines. J. von Lauer (From Oesterreichische Zeitschrift für Berg-und Hüttenwesen. Describes several different methods and the systems of firing, calling attention to the advantages. 4,000 w.) Col Guard—Jan. 22, 1897. No. 10,712. 30 cts.

ELECTRICAL POWER. See title "Mining" under Electrical Engineering, Power.

ELECTRICITY in Mines, Safe Use of. H. W. Ravenshaw (Some common causes of danger and how to guard against them. Suggestions regarding construction of electrical machinery to prevent shocks, sparks, firing of gas and other accidents. 4,000 w.) Col Eng—Jan., 1897. No. 10,477. 30 cts.

ELECTRICITY in the Mining Industry, Influence of (Illustrated review of the applications of electricity to mining and the merits which have popularized it with those who have used it in mining and milling operations. 1,500 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,377. 15 cts.

FLEUSS Breathing Apparatus as a Life-Saving Appliance, &c., for Use in Coal Mines, The Improved. George H. Winstanley (Read before the Manchester Geological Soc. Describes the apparatus and its action. 3,000 w.) Col Guard—Jan. 15, 1897. No. 10,584. 30 cts.

ILLUMINANTS Employed in the Lighting of Mines, Photometric Value of Various. A. H. Stokes (Read before the Federated Inst. of Min. Engs., England. Experiments made to determine the relative amount of light obtained from the illuminants used in mines, to define their economical value, to point out certain adjuncts used for increasing their lights and to call attention to defects and dangers which occasionally accompany their use. 3,000 w.) Am Gas Lgt Jour—Jan. 25, 1897. No. 10,609. 15 cts.

INCLINES, Crossing the Ends of the Ropes in Self-Acting. M. Combalot (From a communication to the Société de l'Industrie Minérale. States the advantage of the arrangement, difficulties to be avoided, conditions to be realized during the lift, &c., with directions for laying down an incline with the rope ends crossed. 5,300 w.) Col Guard—Jan. 15, 1897. No. 10,586. 30 cts.

MACHINE COAL Mine, An Illinois (Illustrated description of the mine, shaking screens, haulage plant, main entries, rooms, roof and machines. 2,000 w.) Eng & Min Jour—Feb. 6, 1897. No. 10,912. 15 cts.

METALLIFEROUS Mining in 1896 (Editorial review showing that, though the market has been depressed, the industry has made important progress during the year. The subject is treated in detail. 3,000 w.) Min Jour—Jan. 2, 1897. No. 10,362. 30 cts.

METAL MINING in Hungary (Describes the occurrence of gold and other metals. 800 w.) Am Mfr &Ir Wld—Jan. 29, 1897. No. 10,704. 15 cts.

MINING Sketches. Arthur Lakes (A view of the San Juan region, Col., from Engineer Mountain. A pen picture of the mountain scenery and an account of a trip with a party of experts to some mines in Mastodon and Poughkeepsie gulches and on Mineral Point. Illustrated. 1,300 w.) Col Eng—Jan., 1897. No. 10,476. 30 cts.

OIL. The Shale Oil Industry in Scotland (L'Industrie des Hailes de Schiste, Méthodes Ecossaises.) (A description of the Young-Beilby furnaces for distilling oil and paraffin from shale. 5,000 w.) La Revue Technique—Dec. 25, 1896. No. 10,767. 30 cts.

PROMOTERS and Promoted, or, Why Mining Investments Are Generally Unprofitable. Edmund B. Kirby (Calls attention to some reasons why mining investments are often a game of chance. 3,000 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,379. 15 cts.

PYROMETER, The Le Chatelier (Das Pyrometer Von Le Chatelier.) (A description of the thermo-electric pyrometer of Le Chatelier, by means of which temperature may be accurately measured up to the melting point of platinum. 3,000 w.) Zeitschr d Oesterr Ing u Arch Vereines—Jan. 1, 1897. No. 10,751. 15 cts.

RARE METALS. The Utilization of Rare Minerals (Utilisation Industrielle des Terres Rares.) (An account of the use of minerals containing thorium for the production of Welsbach light mantles, with suggestions for the utilization of by-products. 1,000 w.) La Revue Technique—Dec. 25, 1896. No. 10,766. 30 cts.

SHAFT at the Anzin Colliery, Widening a. M. J. Prud'homme (From a letter to the northern section of the Société de l'Industrie Minérale. Gives the main lines of the project, with the principles of the methods used. 3,000 w.) Col Guard—Jan. 8, 1897. No. 10,506. 30 cts.

TUNNELS in Colorado, Some Important Mining. Thomas Tonge (Descriptive of the Bobtail, Revenue, Cowenhoven, Newhouse, United States, Pennsylvania, Knickerbocker and other mining tunnels. Ill. 3,900 w.) Eng Mag—Feb., 1897. No. 10,297. 30 cts.

VENTILATING Fan, What Is an Efficient Type of? William Clifford (Address opening the discussion at the W. Penna. Cent. Min. Inst. 1,100 w.) Am Mfr & Ir Wld—Jan. 22, 1897. No. 10,627. 15 cts.

WYOMING Mining Interests. Wilbur C. Knight (Contains reports of coal, petroleum, iron, soda, plaster, asbestos and mica. Only coal mines have been developed, but the state's resources are varied and extensive. The writer considers it reasonable to expect the discovery of valuable gold deposits, and reviews causes which have retarded the growth of the state. 2,400 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,378. 15 cts.

MISCELLANY.

EDUCATION, Technical and Mining. Regis Chauvenet (The writer considers that the value of such training is now admitted, and considers location and equipment of the institution, course and methods of instruction. 2,300 w.) Min Ind & Rev—Dec. 31, 1896. No. 10,380. 15 cts.

FLUXING Rocks of Alabama Geologically Considered, The. Henry McCalley (Describes the formation, location, &c., of the various groups, with remarks on their use. 1,400 w.) Eng & Min Jour—Jan. 30, 1897. No. 10,677. 15 cts.

FREAKS of Nature, Common. Arthur Lakes (Illustrated description of concretionary structures formed in coal, iron and other mines. 1,500 w.) Col Eng—Jan., 1897. No. 10,475. 30 cts.

FURNACE Construction and Management, Practical Notes On. Herbert Lang (The author designs to present a series of letters on every-day aspects of smelting and other branches of metal production, with the object of eliciting discussion. Part 1st deals with furnace construction. 1,800 w.) Eng & Min Jour—Jan. 23, 1897. No. 10,558. 15 cts.

GRANITE Country, The West of England. Arthur Lee (Illustrated description of these quarries and their beautiful surroundings. 1,200 w.) Stone—Jan., 1897. Serial. 1st part. No. 10,615. 30 cts.

HYDRAULIC Mines, Amount of Loss to California Due to Closure of (Considers the loss under three headings: 1st, direct loss of the gold formerly produced by the mines; 2d, depreciation in value of the property and equipment; 3d, the loss to sympathetic industries. 1,300 w.) Min & Sci Rev—Jan. 16, 1897. No. 10,549. 15 cts.

MARBLE HILLS, The Vermont. From N. Y. Post (Historical account of the quarries near Rutland and the progress of the marble industry. 2,000 w.) Stone —Jan., 1897. No. 10,616. 30 cts.

LEAD Blast Furnaces, Wall Accretions of. Malvern W. Iles (In the opinion of the writer these accretions can never be entirely prevented, but to a certain extent can be controlled. An examination of the causes and statements with reference thereto are given, with other interesting information. 1,800 w.) Sch of Mines Quar—Nov., 1896. No. 10,935. 45 cts.

METAL Markets in 1896, The London (Market reports on antimony, lead and spelter. 2,500 w.) Eng & Min Jour—Jan. 9, 1897. No. 10,307. 15 cts.

MINERAL Industry, The. (Editorial review of C. Le Neve Foster's report to the Home Office upon the mineral industries of the United Kingdom. 1,900 w.) Engng—Jan. 8, 1897. No. 10,501. 30 cts.

TINPLATE Trade in 1896, The (Records of the most unfortunate year ever known in the industry in Great Britain. 1,500 w.) Ir & Coal Tr Rev—Jan. 1, 1897. No. 10,366. 30 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

AMMONIA, Sulphate of,. H. H. Cousins (Part first discusses its source and manufacture, purity and impurities, annual production, &c. 1,300 w.) Jour Gas Lgt—Jan. 26, 1897. No. 10,893. 30 cts.

ASCENSION Pipes, Stopped. S. Carpenter (Observations and suggestions arising from the experience of the writer. 1,700 w.) Jour Gas Lgt—Jan. 12, 1897. No. 10,538. 30 cts.

ACETYLENE, Carbide of Calcium and (Discusses the prospects for producing acetylene at an economical rate and gives illustrations and explains the construction of various electric furnaces. 3,000 w.) Eng, Lond—Jan. 15, 1897. No. 10,587. 30 cts.

BY-PRODUCTS of Gas Works, The Nitrogenous (States the extreme gravity of the conditions of gas manufacture in England, showing how largely the commercial success depends on the returns from the by-products, and briefly examines some of the processes for the recovery of cyanogen. 2,800 w.) Eng, Lond—Jan. 22, 1897. No. 10,706. 30 cts.

GAS CONTROL from Meter to Burner. D. Macfie (Abstract of a lecture delivered in Edinburgh. Consideration of size of pipes, burners and many points of interest. 5,000 w.) Jour Gas Lgt—Jan. 19, 1897. No. 10,699. 30 cts.

HEFNER LAMPS, Influences of the Atmosphere upon the. E. Boistel (From L'Industrie Electrique. Information concerning the luminous intensity of the Hefner lamp, and of the pentone lamp having been reported, the object of the paper is to analyze these reports and make a comparison of the two standards. 4,000 w.) Pro Age—Feb. 1, 1897. No. 10,915. 15 cts.

LIGHTING Appliances, Primitive (Illustrated description of an interesting collection. Extract from article by Prof. Drehschmidt and Dr. E. Engels, in Journal für Gasbeleuchtung." 1,200 w.) Gas Wld—Jan. 2, 1897. No. 10,368. 30 cts.

MANUFACTURE and Appliances, Gas. Henry O'Connor (It is proposed to examine not only the reasons for the several steps in gas manufacture, but also the constructive details of the works, preparation of the various pieces of machinery, strength of parts, tests of apparatus, &c. 2,400 w.) Gas Wld—Jan. 2, 1897. Serial. 1st part. No. 10,367. 30 cts.

PURIFYING Material, Revivification or Regeneration of. Dr. W. Leybold (The method is described and the chemical action explained. Also manner of testing to determine whether the material is completely revivified. 1,500 w.) Pro Age—Feb. 1, 1897. No. 10,914. 15 cts.

RETROSPECT of the Year 1896, A (Review giving especial attention to the gas industry. 3,500 w.) Jour Gas Lgt—Dec. 29, 1896. No. 10,341. 30 cts.

SUPPLY, Gas (Editorial review of the past year in England. 500 w.) Eng, Lond—Jan. 1, 1897. No. 10,411. 30 cts.

TESTING Coal Gas. Norton H. Humphreys (Discusses a paper by T. Glover on the "Commercial Testing of Coal Gas." 3,800 w.) Jour Gas Lgt—Dec. 29, 1896. No. 10,342. 30 cts.

TRANSFORMATION into Alkaline Ferrocyanides of the Sulphocyanides Produced During the Manufacture of Illuminating Gas. M. Andre Dubosc (Communicated by the author to the Industrial Society of Rouen. Examines the importance of the by-products comprised under the general classification of sulpho and ferrocyanides. 1,300 w.) Am Gas Lgt Jour—Feb. 8, 1897. No. 10,920. 15 cts.

WATER GAS, A Survey of the Position of. Dr. Hugo Strache (Brief digest of an address to the chemical section of the Lower Austrian Industrial Association. Summarizes merits, recent improvements, &c. 1,800 w.) Jour Gas Lgt—Jan. 5, 1897. No. 10,448. 30 cts.

WATER GAS, Notes on Carburetted. A. G. Glasgow (Read before the Cleveland Inst. of Engs., Jan. 11, 1897. Gives history, fundamental theory, nature of process, description of apparatus, chemical and physical properties, character of flame, advantages, estimates of cost, &c. 5,000 w.) Gas Wld—Jan. 16, 1897. No. 10,602. 30 cts.

WATER GAS. The Present Status of the Water Gas Question (Der Stand der Wassergasfrage) (A strong plea for the introduction of water gas, by Dr. Hugo Strache. 2,500 w.) Wiener Bauindustrie Zeitung—Jan. 14, 1897. No. 10,763. 15 cts.

SEWERAGE.

BLANKENBERGHE, Notes on the Sewerage of (Illustrated description of a system which consists in carrying all matters into sewers and using the sewage for fertilizing the land. 2,800 w.) Eng, Lond—Jan. 1, 1897. Serial. 1st part. No. 10,405. 30 cts.

CHEMICAL Precipitation at Hamilton, Ont., Sewage, Disposal by. E. G. Barrow (Brief illustrated account of the works now being constructed. 900 w.) Eng News—Jan. 28, 1897. No. 10,667. 15 cts.

DRAINAGE as Applied to Country Houses. W. J. Wells (Read before the Inst. of Sanitary Engs. Part first presents the difficulties to be overcome in rural drainage and deals briefly with cesspools. 1,600 w.) San Rec—Jan. 22, 1897. No. 10,850. 30 cts.

DRAINAGE; Its Workmanship and Control. R. Thornton (Read at meeting of Staffordshire Assn. of Sanitary Inspectors. Advocates the use of the best material; discusses the fall in the drain, traps, fittings, joints, &c. 1,600 w.) San Rec—Jan. 29, 1897. Serial, 1st part. No. 10,938. 30 cts.

DRAINAGE, Rural (Briefly discusses the methods which are utilized with more or less success for the disposal of sewage; gives early use of sewers, &c. From "The Builder." 4,000 w.) Dom Engng—Jan., 1897. No. 10,746. 30 cts.

DRAINAGE Works, Delhi. B. Parkes (Part first gives a synopsis of various projects framed for the sewerage of Delhi, and plan showing route of intercepting sewer and city ditch. 1,600 w.) Ind Engng—Dec. 12, 1896. Serial, 1st part. No. 10,473. 45 cts.

RIVER-POLLUTION in England (The pollution of the Irwell and the Mersey by manufacturers and sewage discharges, and the action taken in the matter. 1,300 w.) Fire and Water—Jan. 23, 1897. No. 10,612. 15 cts.

SEWAGE DISPOSAL Works, Hamilton (Illustrated description of this efficient system. 1,500 w.) Can Eng—Jan., 1897. No. 10,482. 15 cts.

SEWAGE LIFT, Some Applications of an English (Describes and explains the use of the Adams sewage lift. Ill. 800 w.) Eng Rec—Feb. 6, 1897. No. 10,922. 15 cts.

SEWER GAS and Its Disposal. Paul Plimton (Discusses the methods that have been suggested and the need of attention to this subject. 1,100 w.) San Plumb—Feb. 1, 1897. No. 10,870. 15 cts.

SEWER GAS: Its danger to Health. Dr. Joseph Priestley (Explains the source of sewer gas and its dangers. 1,800 w.) San Rec—Jan. 8, 1897. No. 10,511. 30 cts.

SEWER SYSTEM, Peoria, Ill., West Bluff. A. D. Thompson (Illustrated detailed description of the design and construction, cost, &c. 4,800 w.) Eng News—Jan. 28, 1897. No. 10,661. 15 cts.

STREETS AND PAVEMENTS.

BRICK Paving in Small Towns. A. W. Smith (Condensed from paper read before the Indiana Engng. Soc. Advocating the use of good vitrified brick. 1,100 w.) Munic Engng—Feb., 1897. No. 10,743. 30 cts.

MOVABLE SIDEWALK. The Blot Movable Railway (Cheminde Fer à Voie Mobile, Système A. Blot. A description of plans for a travelling sidewalk for the Paris Exposition of 1900. 3,000 w.) La Revue Technique—Jan. 10, 1897. No. 10,774. 30 cts.

PAVEMENTS, Confined Rivers and the Water Supply of Ancient Rome. Francis W. Blackford (A report of the pavements of Paris, London, Rome and other foreign cities; the river walls within the cities; and a study of the ancient water supply of Rome. Ill. 4,000 w.) Jour Assn of Engng Socs—Dec., 1896. No. 10,641. 30 cts.

PAVING, German "Hit and Miss." Robert Grimshaw (Illustrated description of this form of pavement. 800 w.) Munic Engng—Feb., 1897. No. 10,741. 30 cts.

SPEEDWAY. See same title under Civil Engineering, Miscellany.

STREET-CLEANING to Good Paving, Relations of. George E. Waring, Jr. (Showing that imperfect paving greatly increases and sometimes doubles the cost of street-cleaning, and comparing the qualities of different types of pavement from the cleaner's point of view. 2,200 w.) Eng Mag—Feb. No. 10,298. 30 cts.

STREET IMPROVEMENTS, Methods of Paying for. Charles Carroll Brown (The numerous methods are classified and brief reference made to certain cities. 2,000 w.) Munic Engng—Feb., 1897. No. 10,739. 30 cts.

STREET RAIL and Its Relation to Pavements, The Modern. J. W. Howard (The kinds of rail and their effect on adjacent pavement are briefly considered. 700 w.) Munic Engng—Feb., 1897. No. 10,742. 30 cts.

TRACKS and the Pavements in New York, The Street Railway. George E. Waring, Jr. (Illustrated description of sections of rail and pavement in various parts of New York, with commendation of the track as laid in Vienna, and urging the correction in N. Y. City. 1,300 w.) Harper's Weekly—Feb. 13, 1897. No. 10,969. 15 cts.

WATER SUPPLY.

CAPACITY of Water Works in American Cities, Ownership and (Tabulated statement of cities between 50,000 and 100,000, with explanations. 700 w.) Munic Engng—Feb., 1897. No. 10,740. 30 cts.

FILTRATION Plant at Lexington, Ky., Alum Feeder for the (Illustrations and description. 700 w.) Eng News—Jan 14, 1897. No. 10,456. 15 cts.

HYDROGRAPHIC Surveys in Montana. See same title under Civil Engineering, Irrigation.

JERSEY CITY Water Contract, A Reply to the Expert Report on the Proposed (Extracts from reply by C. C. Vermeule, with remarks. 900 w.) Eng News—Feb. 4, 1897. No. 10,900. 15 cts.

JERSEY CITY Water Question, The Report of Mr. George W. Rafter on the (Special report to the Board of Trade discussing the proposed contract of the city with the East Jersey Water Co. for a water supply. 1,100 w.) Eng Rec—Jan. 23, 1897. No. 10,598. 15 cts.

OMAHA, The Water Works Question in (Report with editorial comment. 4,800 w.) Eng Rec—Jan. 9, 1897. No. 10,335. 15 cts.

OMAHA Water Works, Facts Regarding the. Howard Mansfield (A statement called forth by an article published in this paper which the writer claims is a misrepresentation. 1,600 w.) Eng Rec—Feb. 6, 1897. No. 10,924. 15 cts.

ORGANISMS, Water Supply and Sewerage as Affected by the Lower Vegetable. Clarence O. Arey (From a paper read at Cleveland, O. The study begins with a consideration of the lowest forms of life and the subject of water supplies. 1,500 w.) Fire & Water—Jan. 9, 1897. Serial. 1st part. No. 10,372. 15 cts.

PARIS, The Water Supply of—Ite Rise and Progress (Historical particulars with valuable data, from report of chief engineer. 2,200 w.) Jour Gas Lgt—Jan. 12, 1897. Serial. 1st part. No. 10,539. 30 cts.

PUMPING SYSTEM. The Pumping Plant of the Sewerage System of Budapest (Pumpmaschinen der Budapester allgemeinen Kahallsationwerke). (A description of the high and low pressure pumping machinery for the sewerage of Budapest. 3,000 w. and 1 plate.) Zeitschr d Ver Deutscher Ing—Jan. 2, 1897. No. 10,758. 20 cts.

PURIFICATION of Water, The. Frank J. Thornbury (Discusses the various methods in common use for purifying water, showing why they are not successful. 2,500 w.) Chau—Feb., 1897. No. 10,670. 30 cts.

RESERVOIR, Greater Boston's New. Charles H. Bemis (An illustrated account of a great undertaking, the cost of which may reach $50,000,000. The dam will be nearly nine miles long, and will cover 4,195 acres to a depth of 46 feet. 2,000 w.) Harper's Weekly—Jan. 16, 1897. No. 10,356. 15 cts.

RESERVOIRS. The Control of Bodies of Water and the Action of Reservoirs in General (Die Seeretention, sowie das Wirken der Reservoire im allgemeinen A mathematical investigation of reservoirs, taking into account various rates of inflow and outflow. 6,000 w. and 1 plate.) Oesterr Monatschr f Oeffent Baudienst—Jan., 1897. No. 10,779. 30 cts.

SMALL TOWNS and Rural Districts, The Water Supply of. Percy Griffith (Extracts from a paper read at a meeting of the Soc. of Engs. Consideration of features applicable to works supplying a maximum population of 10,000. 3,000 w.) Jour Gas Lgt—Jan. 26, 1897. No. 10,894. 30 cts.

VIENNA WATER WORKS. The Pumping Station of the Vienna Water Works at Breitensee (Das Wiener Städtische Schöpfwerk in Breitensee). (A brief description of an 8,000,000 gallon pumping station, with Riedler pumps. 2,000 w.) Wiener Bauindustrie-Zeitung—Jan. 14, 1897. No. 10,762. 15 cts.

WATER FAMINE in Brooklyn, The. George E. Waring Jr. (Advises the controlling of waste, and shows that the amount wasted sometimes exceeds the amount used. 1,100 w.) Harper's Weekly—Feb. 6, 1897. No. 10,869. 15 cts.

WATER-SUPPLY (Editorial Review of the past year in Great Britain. 2,000 w.) Eng, Lond—Jan. 1, 1897. No. 10,410. 30 cts.

WATER-SUPPLY of Ancient Rome, Pavements, Confined Rivers and the. Francis W. Blackford (An account of the water supply of ancient Rome is given; also some details and technicalities of the pavements of Paris, London, Rome and other foreign cities and the well-built river walls. Ill. 4,000 w.) Jour Assn of Engng Socs—Dec., 1896. No. 10,641. 30 cts.

MISCELLANY.

FILTERING Materials, Mechanical Analysis of. Allen Hazen (Describes the manner of testing and methods of comparison, the record of results, and all details of the work. 1,800 w.) Eng Rec—Jan. 23, 1897. No. 10,599. 15 cts.

GARBAGE Disposal. H. C. Garneau (Description of process patented by Adolf Merz, of Brunn, Moravia, and in use by the St. Louis Sanitary Co. 1,500 w.) Yale Sci M—Jan., 1897. No. 10,530. 30 cts.

GLASGOW, The Atmosphere of—and Its Effects (The effects discussed are chiefly on statuary, decorations, buildings, etc. 3,000 w.) Arch, Lond—Jan. 8, 1897. No. 10,493. 30 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

ELEVATION of the N. Y., N. H. and H. RR. at Boston, Mass. (Illustrated description of a costly piece of work, including construction of bridges and stations, laying of sewers and water-mains, elevation of freight yards and incidental work 2,800 w.) Eng News—Jan. 14, 1897. No. 10,450. 15 cts.

LONDON, New Railways for (Map showing the new railways for London in the several stages of progress, with interesting information concerning them. 1,800 w.) Eng Lond—Jan. 22, 1897. No. 10,707. 30 cts.

SENEGAL-NIGER Railway (Le Chemin de Fer du Sénégal au Niger). (The first of a series of articles describing the railway now being constructed to unite the upper navigable waters of the Senegal and the Niger. 5,000 w. Map.) La Revue Technique—Jan. 10, 1897. No. 10,771. 30 cts.

TRACK ELEVATION in Jersey City, Erie (Plans showing proposed elevation of the tracks, with explanation of the situation. 1,100 w.) RR Gaz—Jan. 29, 1897. No. 10,680. 15 cts.

SYRIA, The Railway Beyreuth-Damascus-Hauran in (Description of the line, with the difficulties of construction, etc. 1,300 w.) Eng, Lond—Jan. 8, 1897. No. 10,508. 30 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

AIR-BRAKE System, Two-Pipe (Illustrated description of device as given by Mr. Westinghouse in his patent specifications. 1,400 w.) Loc Engng—Feb., 1897. No 10,892. 30 cts.

AXLES, Comparative Abrasion Tests of (Records of an interesting series of wearing tests on a number of car-axles conducted at the laboratory of the Cambria Iron Co. Gives results and chemical analyses. 1,000 w.) Ry Mas Mech—Jan., 1897. No. 10,350. 15 cts.

BALANCED Slide Valves for Locomotives (Editorial comment on the extensive use of this valve in America and its scant favor in England, with some explanatory reasons. 1,100 w.) Eng, Lond—Jan. 22, 1897. No. 10,710. 30 cts.

BOLSTERS, Calculating the Strength of Body and Truck (Part first considers the truck bolster only. 1,000 w.) Ry Mas Mech—Feb., 1897. No. 10,909. 15 cts.

BOX CARS, Standard Dimensions for Interchange (A table is given showing suggested standards reported to date, with editorial comment. 2,000 w.) R R Gaz—Jan. 22, 1897. No. 10,565. 15 cts.

BUFFER Blocks for Freight Equipment, Spring (Illustrated description of design from the Gould Coupler Co. 900 w.) Ry Mas Mech—Feb., 1897. No. 10,911. 15 cts.

COAL CAR, 65,000 Pounds Capacity, Double Drop-Bottom (Illustrated description of a car for heavy service, the design of C. E. Turner. 800 w.) Loc Engng —Feb., 1897. No. 10,889. 30 cts.

COMPOUND Passenger Locomotives (Editorial discussion of the value of the compound locomotive in handling fast passenger traffic. 1,200 w.) Ry Rev—Jan. 30, 1897. No. 10,723. 15 cts.

COUPLERS, Defects in M. C. B. M. J. Lorraine (Letter to the editor criticising the contour and other points. Ill. 1,500 w.) Ry Rev—Feb. 6, 1897. No. 10,941. 15 cts.

COUPLERS, Experiments on the Lateral Movement of (Diagram illustrating experiments made on the C. & N. W. Ry., with explanation. 900 w.) Ry Mas Mech —Jan., 1897. No. 10,351. 15 cts.

DOORS, Freight Car (An amusing paper by R. P. C. Sanderson, read at meeting of Southern Railway Club. 1,800 w.) Loc Engng—Feb., 1897. No. 10,890. 30 cts.

DRIVING-WHEELS, Larger (High speed in freight service has led to a reduction in the number of wheels and an enlargement in diameter on freight locomotives. 1,000 w.) R R Car Jour—Jan., 1897. No. 10,357. 15 cts.

EXPRESS LOCOMOTIVES, Some Noteworthy. George Frederick Bird (A brief history of some of the express locomotives of the past and present. Ill. 8,000 w.) Eng, Lond—Jan. 29, 1897. No. 10,957. 30 cts.

LOCOMOTIVES in England and America, Pioneer. Alfred Mathews (Descriptive of the earliest experiments in the construction and use of locomotives. Ill. 4,200 w.) Eng Mag—Feb., 1897. No. 10,300. 30 cts.

LOCOMITIVE, The Construction of a Modern. William O. Webber (Descriptive. 2,300 w.) Tradesman—Feb. 1, 1897. No. 10,727. 15 cts.

LOCOMITIVE Design, An Important Feature of (Editorial discussion of improvements needed to provide for fast passenger schedules. Gives Prof. Goss's conclusions regarding larger driving wheels and suggests lines along which to seek improvement. 2,000 w.) Ry Rev—Jan. 16, 1897. No. 10,499. 15 cts.

LOCOMOTIVE, Mogul—Vandalia Line (Illustrated description, with dimensions. 400 w.) Ry Rev—Jan. 9, 1897. No. 10,455. 15 cts.

LOCOMOTIVES, Fast Express, for the N. Y. C. & H. R. R. R. (Illustrated description, with discussion. 800 w.) Eng News—Jan. 14, 1897. No. 10,452. 15 cts.

LOCOMOTIVES, Treatment of—by Enginemen. L. D. Westfall (Calls attention to some points where a little care will save wear and repair costs, and the economy of fuel, oil, &c. 1,600 w.) Ry Mag—Jan., 1897. No. 10,647. 30 cts.

LOCOMOTIVES, New Eight-Wheel Passenger—Illinois Central Railroad (Illustrated detailed description of engines designed by William Renshaw, with dimensions. 1,400 w.) R R Gaz—Feb. 5, 1897. No. 10,906. 15 cts.

PASSENGER COACH, A Copper Sheathed (Describes a novelty in passenger car construction recently made in the shops of the N. Y., N. H. & H. RR. 900 w.) R R Gaz—Jan. 29, 1897. No. 10,682. 15 cts.

PUSHER Locomotive for the B. R. & P. Ry., Twelve-Wheel (Illustrated description of a very large engine to be used in helping coal trains over a grade of 58 ft. to the mile. Gives general dimensions. 300

w.) Eng News—Jan. 21, 1897. No. 10,554. 15 cts.

RACK RAIL Locomotives, Damascus Railway (Illustrated description. 400 w.) Eng, Lond—Jan. 15, 1897. No. 10,589. 30 cts.

ROLLING STOCK, Suggestions for Specifications for New. A. M. Waitt (From a paper read before the Western Railway Club. Calls attention to the need of careful consideration in the selection of materials, the care and inspection of equipment, &c. Editorial comment is also made. 4,500 w.) Ry Rev—Jan. 23, 1897. 10,646. 15 cts.

TRAIN, an Innovation on the Southeastern (Illustrated description of train on the American plan introduced on the Southeastern Railway of England. It is very largely patronized and will be followed by similar trains. 2,000 w.) Ry Wld—Jan., 1897. No. 10,419. 30 cts.

TRUCK, Freight—of Rolled Shapes (Illustrated description of truck designed by Mr. Pulaski Leeds. 700 w.) RR. Car Jour—Jan., 1897. No. 10,357. 15 cts.

TRUCK, The Brill "Perfect" Passenger (The object in the design was to provide additional safety against derailments, improvement in riding qualities and the relieving the wheels of stresses other than those due to the weight of the car. Illustrated description. 1,200 w.) Ry Rev—Feb. 6, 1897. No. 10,940. 15 cts.

MAINTENANCE OF WAY AND STRUCTURES.

FREIGHT STATION at Columbus, O., for the Pittsburg, Cincinnati, Chicago and St. Louis Ry., New (Illustrated detailed description. 1,000 w.) Eng News—Feb. 4, 1897. No. 10,896. 15 cts.

FROG, Spring Rail; Union Pacific Ry. (Illustrated description of design by George H. Pegram. 500 w.) Eng News—Feb. 4, 1897. No. 10,897. 15 cts.

JOINTS, Welded Rail (Editorial review of recent improvements in rail joints. 1,000 w.) Sci Am—Jan. 16, 1897. No. 10,436 15 cts.

SANDBERG Rails. A. L. Uggla (Theoretical consideration of an 80-lb. rail section adopted by the state railways in Sweden, with brief description of others whose weights are from 100 lb. to 30 lb. per yard. 1,000 w.) Engng—Jan. 29, 1897. No. 10,948. 30 cts.

SECTIONS and Weights Again, Rail (Editorial on the progress in increasing weights of rails and in the adoption of a standard section. 1,000 w.) RR Gaz—Jan. 15, 1897. No. 10,462. 15 cts.

TRAFFIC on American and Foreign Railways, The Relations of Track to. E. E. Russell Tratman (Information acquired in the course of extensive investigations of this subject is presented and discussed, with details in tabular form for comparison. 3700 w.) New York RR Club—Dec. 17, 1896. No. 10,487. 45 cts.

SIGNALLING.

ELECTRIC Interlocking System, The Taylor (Illustrates and describes an interesting installation at Edgewood, Ill., which has a number of novel features and promises success. 1,300 w.) Ry Rev—Jan. 9, 1897. No. 10,467. 15 cents.

PRACTICE in Railroad Signalling, Recent. George W. Blodgett (The progress that has been made in the last ten or twelve years and the standard practice of to-day so far as it is well established. Ill. 6,000 w.) Jour Assn of Engng Socs—Dec., 1896. No. 10,638. 30 cents.

TERMINALS AND YARDS.

BOSTON, The New Southern Terminal Station at (Considers in detail the proposed arrangement. When this is completed, all the railway traffic will be concentrated at two union stations. 3,000 w.) Eng News—Jan. 14, 1897. No. 10,455. 15 cts.

TERMINALS at Providence, R. I., The New Railway (Account of the local conditions and the problems to be solved in this work, with illustrated description. 3,000 w.) Eng News—Jan. 28, 1897. No. 10,665. 15 cts.

TRANSPORTATION.

COAL-HANDLING Machinery at Gladstone, Mich. Karl J. C. Zinck (Description of a coal-unloading and conveying machine. 700 w.) Eng News—Feb. 4, 1897. No. 10,898. 15 cts.

EARNINGS in 1896, Railroad (Comment on the reports as given in the Financial Chronicle, Dun's and Bradstreet's. 1,400 w.) R R Gaz—Jan. 22, 1897. No. 10,568. 15 cts.

CONTINENTAL Railway Facilities (Editorial asserting that nowhere is it possible for the ordinary traveller to be carried so rapidly and so cheaply as in England. The criterion adopted is the average speed over the system. Makes comparison with Continental railways. 2,000 w.) Engng—Jan. 8, 1897. No. 10,500. 30 cts.

INTERSTATE Commerce Law. Violations of the Act to Regulate Commerce. Judge Grosscup's Charge to the Jury in the Hanley Case (The charge is given in full on account of the complete statement of the law and the facts in the case. With editorial comment. 4,900 w.) Ry Rev—Jan. 16, 1897. No. 10,498. 15 cts.

MILEAGE; Locomotive—Increased by Long Runs (From a paper by C. W. Eckerson before the St. Louis Ry. Club. The writer believes there is an economy to be obtained by increasing the runs of engines and presents arguments. 2,400 w.) Ry Rev—Jan. 9, 1897. No. 10,466. 15 cts.

POOLING Bill, The (Communication

to the Committee on Interstate and Foreign Commerce, with editorial comment. 3,400 w.) Ry Rev—Feb. 6, 1897. No. 10,943. 15 cts.

MISCELLANY.

ACCIDENTS in the United States in December,Train (List of accidents for the month and their causes, with classified summary. 2,500 w.) R R Gaz—Jan. 29, 1897. No. 10,681. 15 cts.

BANKRUPTCIES in 1896, Railroad (Records of the year's foreclosures and receiverships are presented with comment. 900 w.) Bradstreet's. Jan. 9, 1897. No. 10,340. 15 cts.

BARSI Light Railway; Details of Pressed Steel Bogie (Plan and profile with mean elevation and description of the experimental line constructed near Leeds for the purpose of illustrating the method of working adopted in the Barsi Light Railway. Also illustrated description of rolling stock. 2,400 w.) Engng—Jan. 22, 1897. No. 10,705 30 cts.

BOILER PLANT Chicago Shops, C. R. I. & P. Railway (Illustrated description. 800 w.) Ry Rev—Feb. 6, 1897. No. 10,942. 15 cts.

BUDAPEST, the Railway Exhibits at the Millennial Exposition at—1896 (Das Eisenbahnwesen auf der Millenmums-Landesausstellung in Budapest, 1896) (Description of roadway and locomotives, with details of compound locomotives and plate of four-cylinder tandem compound engine. 5,000 w.) Zeitschr Ver Deutscher Ing—Jan. 9, 1897. No. 10,760. 20 cts.

CHANCES of Success. The Young Man and His. M. M. Kirkman (An outline of the conditions attending railway operation in relation to the success of young men seeking employment therein. From the Chicago World. 2,200 w.) Ry Rev—Jan. 30, 1897. No. 10,722. 15 cts.

COLLEGE COURSE, Railroading as a. R. L Donald (Relates the experience of one who has endeavored to obtain such a course. 1,400 w.) R R Gaz—Jan. 22, 1897. No. 10,562. 15 cts.

COMMISSIONERS' REPORT, Massachusetts Railroad (Extracts from report with remarks. 1,200 w.) R R Gaz—Feb. 5, 1897. No. 10,905. 15 cts.

COUPLER Decision, A Review of the Recent. Dyer Williams (The writer differs from the court in the findings and decision in the case of the Shickle, Harrison & Howard Iron Co. vs. St. Louis Coupler Co. 1,200 w.) Ry Age—Jan. 8, 1897. No. 10,364. 15 cts.

ELECTRIC Power on the B. & O., Some Results with. T. Fitzgerald (A brief review of the growth of the enterprise and a statement of its success. 900 w.) Elec Eng—Jan. 6, 1897. No. 10,312. 15 cts.

ELECTRIC TRACTION. See title "Traction Under Steam Railway Conditions," under Street and Electric Railways, Power.

LEHIGH VALLEY R. R., Annual Report of the (The results of a year which was unprofitable to nearly all the anthracite-coal carrying roads, with brief review of new lines, &c. 1,600 w.) R R Gaz—Jan. 22, 1897. No. 10,569. 15 cts.

"MIDLAND-SCOTTISH," With the. Charles Rous-Marten (An analysis of the working of this line. 2,500 w.) Eng, Lond—Jan. 29, 1897. No. 10,956. 30 cts.

NEW YORK Railroad Commissioners' Report (Review of the fourteenth annual report. 1,700 w.) R R Gaz—Jan. 15, 1897. No. 10,459. 15 cts.

PERU, the Tallest Railroad. Charles E. Lummis (An illustrated account of the remarkable railroads of Peru. 3,600 w.) Harper's Weekly—Jan. 23, 1897. No. 10,529. 15 cts.

RAPID TRANSIT Tunnel, A Brooklyn and New York (A plan for removing steam-railway traffic from the surface of Atlantic avenue and for improving rapid transit facilities. Proposes an electric line, partly elevated and partly in tunnel, with a tunnel under the East River and a terminal at Church and Cortlandt streets, New York. 1,400 w.) Eng News—Jan. 14, 1897. No. 10,453. 15 cts.

RELIEF Departments, Railway. Emory R. Johnson (Reviews their history, plan of organization, various features and results. 6,300 w.) Bul of Dept of Labor—January, 1897. No. 10,469. 45 cts.

REPORT of the Massachusetts State Board of Railroad Commissioners (Extracts from report for 1896. Treats of bicycle transportation, car ventilation and grade crossings. 4,000 w.) Eng News—Jan. 28, 1897. No. 10,663. 15 cts.

RUSSIAN Railways. W. J. M'Carroll (Illustrated description of the right of way, track, locomotives, cars, &c. 3,000 w.) Loc Engng—February, 1897. No. 10,888. 30 cts.

SLIDE RULE as an Aid to Railroad Field Work, The. George Duncan Snyder (Displays its adaptability to the numerous calculations necessary in a railroad survey. Gives the settings the author has found useful in his own work, with applications to grades, curves, transition curves, &c. 2,200 w.) R R Gaz—Jan. 22, 1897. Serial. 1st part. No. 10,566. 15 cts.

TAXATION; Methods of Taxing Railroads in the Various States (From the annual report of S. R. Billings, Railroad Commissioner of Michigan. Gives the information in condensed form. 1,800 w.) R R Gaz—Jan. 15, 1897. No. 10,464. 15 cts.

TESTING Laboratory, The C., B. & Q. (Illustrated description of the plant and work. 2,000 w.) Ry Mas Mech—Feb., 1897. No. 10,910. 15 cts.

TRACK SANDING Device for Terminal Stations (Voies Ensablées pour Gares Terminus) (Description of a device by means of which the rails may be sanded automatically by the action of the approaching train. 2,500 w.) La Revue Technique—Dec. 25, 1896. No. 10,769. 30 cts.

STREET AND ELECTRIC RAILWAYS.

GENERAL CONSTRUCTION.

BOSTON SUBWAY, Progress of the (Information gained during a recent visit, relating to the progress of this interesting work, methods, &c. Ill. 2,800 w.) Eng News—Feb. 4, 1897. No. 10,903. 15 cts.

CABLING of Edinburgh Tramways, The (Information as to the extent and nature of the scheme for changing most of the horse tramways to the cable system. 2,400 w.) Ry Wld—Jan., 1897. Serial, 1st part. No. 10.418. 30 cts.

CHALONS - SUR - MAINE, Electric Tramway at (La Traction Electrique à Chalons-sur-Maine) (A description of the opening of a new trolley road, with illustrations of cars, trolley, power-house, &c. 6,000 w.) La Revue Technique—Jan. 10, 1897. No. 10,770. 30 cts.

CLARET - VUILLEUMIER Electric Traction System, The. From "Lightning," London (Brief description of a system recently adopted in Paris, including the successful use of underground conductors. 1,600 w.) Elec Rev—Jan. 20, 1897. No. 10,-527. 15 cts.

CONCRETE Work in Detroit. F. A. Little (Facts derived from the construction of nearly fifty miles of track on a concrete foundation in Detroit. 3,000 w.) St Ry Rev—Jan. 15, 1897. No. 10,524. 30 cts.

DOUGLAS Southern Electric Tramway (An illustrated description of the latest addition to the Manx tramways. 2,800 w.) Ry Wld—Jan., 1897. No. 10,417. 30 cts.

ELEVATED RAILROADS, A Study in the Designing and Construction of—with Special Reference to the Northwestern Elevated Railroad and the Union Loop Elevated Railroad of Chicago, Ill. J. A. L. Waddell (An interesting paper, with illustrations designed to bring out an exhaustive discussion of the subject. 12,-500 w.) Pro Am Soc Civ Engs—Jan., 1897. No. 10,736. 50 cts.

GENEVA, Switzerland, The Street Railway System of (Illustrated description. 800 w.) St Ry Jour—Feb., 1897. No. 10,-729. 45 cts.

GERMAN EMPIRE, Some Electric Tramways in the (Ueber einige elektrische Bahnen im Deutschen Reiche) (An illustrated description of a number of German electric roads, both with overhead and underground conductors. 12,000 w.) Oesterr Monatschr f d Oeffent Baudienst—Jan., 1897. No. 10,777. 30 cts.

INDIA, The Trolley in—The Madras Electric Railway. George Heli Guy (Historical account of the enterprise and the difficulties, with illustrated description. 1,300 w.) Elec Eng—Jan. 6, 1897. No. 10,311. 15 cts.

LOOP, Electrical Equipment of the Union—Chicago (Illustrated description of structure being built by the Loop Construction Co., with the object of providing greatly needed terminal facilities in the downtown business district, to the four elevated railroads. 1,500 w.) W Elec—Jan. 16, 1897. No. 10,481. 15 cts.

PARIS, Electric Tramways in. A New Electric Tramway System in Paris (Un Nouveau Réseau de Tramways a Traction Electrique a Paris) (A discussion of the introduction of electric traction to provide transportation for the exposition of 1900. 3,500 w.) La Revue Technique—Dec. 25, 1896. No. 10,768. 30 cts.

RETURN, Some Further Notes on the Electric Railway. H. S. Newton (Relates experience in Syracuse in matter of rail-bonds, explains in detail the construction of a bond which solders fast to the rail and which seems to have solved the problem of obtaining a good return. Ill. 1,200 w.) St Ry Rev—Jan. 15, 1897. No. 10,-579. 30 cts.

STREET TRACTION in France. From N. Y. Evening Post (A brief account of systems tried in Paris. 1,300 w.) Sci Am Sup—Feb. 6, 1897. No. 10,881. 15 cts.

SUBWAY, The Boston (Part first gives the history, general conditions, map, location, types of construction, general cross sections, ventilation, water proofing, European comparisons, East Boston tunnel, Charlestown bridge, &c. 2,800 w.) Eng Rec—Jan. 23, 1897. No. 10,597. 15 cts.

SUBWAY, The Glasgow District (A few notes and impressions gleaned by a recent visit since the railway opened for public service. 2,500 w.) Ry Wld—Jan., 1897. No. 10,420. 30 cts.

EQUIPMENT.

REPAIR Shop Hints. C. B. Fairchild (Calls attention to points of frequent neglect and wrong policy in management. 2,400 w.) St Ry Jour—Feb., 1897. No. 10,732. 45 cts.

WHEEL FLANGE, The Discussion of

the Proper Shape of. C. F. Uebelacker (Demonstration of a shape of flange which present practice in track laying would call for. Diagrams. 2,000 w.) St Ry Jour—Feb., 1897. No. 10,730. 45 cts.

WHEEL TREADS and Flanges, The Irregular Wear of. H. S. Cooper (The causes and some remedies. Part first considers defects in tracks or rails, defects of wheels and defects in running gear, trucks, motors, or in adjustment of same. 4,500 w.) St Ry Jour—Feb., 1897. Serial. 1st part. No. 10,731. 45 cts.

LINE.

CONTINUOUS Rail, The Problem of the. Ward Raymond (Suggests the best time for welding; the various types of welds are described and the practice approved. 3,300 w.) St Ry Jour—Feb., 1897. No. 10,734. 45 cts.

PAVEMENTS and Street Railway Tracks. See "Tracks" under Municipal Engineering, Streets and Pavements.

SWITCHES for Electric Railways, Stationary (Stationäre Schaltanlagen für Elektrische Bahnen) (A description of the application of the switchboard system to the distribution of currents for motor purposes. 2,500 w.) Deutsche Zeitschr f Elektrotech—Jan. 15, 1897. No. 10,791. 15 cts.

UNDERGROUND Conductor with Closed Slot (Unterirdische Stromzuführung mit Verschlossenem Kanalschlitz) (The Hecker system, in which the slot has a hinged lid which is raised in sections by the car automatically. 3,000 w.) Deutsche Zeitschr f. Elektrotech—Jan. 15, 1897. No. 10,790. 15 cts.

UNDERGROUND System, the Application of Power to Street Railways, with Special Reference to the Lachmann (Die Anwendung der motorischen Kraft für Strassenbahnen, speziell unterirdische Stromzufuhrung, System Lachmann) (A comparison between the various motor systems, by the inventor of the Lachmann underground trolley. 2,500 w.) Elektrotech, Rundschau—Jan. 15, 1897. No. 10,789. 15 cts.

POWER.

COMPRESSED AIR. See title "Motor," under Mechanical Engineering, Compressed Air.

GAS Tramways. A. Lavezzari (A short description of the cars and motor and their operation in actual practice. 2,000 w.) Pro Age—Jan. 15, 1897. No. 10,485. 15 cts.

LONG RAILWAY Lines, Some Practical Suggestions for the Operation of. S. H. Short (Suggests using four smaller motors, one on each axle of the motor car, so arranged as to develop by grouping in parallel, a speed of 40 miles an hour, in series-parallel, 20 miles, and in series, 10 miles. 1,400 w.) Elec Eng—Jan. 6, 1897. No. 10,310. 15 cts.

NEW LONDON, Conn., Street Railway Co., New Power House of the (Illustrated detailed description. 2,000 w.) Elec Eng—Jan. 27, 1897. No. 10,648. 15 cts.

POWER HOUSE, Toledo Traction Company's (Illustrated detailed description. 2,500 w.) St Ry Rev—Jan. 15, 1897. No. 10,522. 30 cts.

STORAGE BATTERIES in Railway Work, The Use of. William Baxter, Jr. (Consideration of the advantages to be derived from their use. 2,800 w.) Elec Wld—Jan. 9, 1897. Serial. 1st part. No. 10,442. 15 cts.

STORAGE Battery Applied to Electric Traction. See same title under Electrical Engineering, Power.

TRACTION, Electric. Edward Barrington (Treats the subject very fully, touching on nearly every form of electric traction now in use. The paper is followed by an extended discussion. 27,800 w.) Jour W Soc of Engs—December, 1896. No. 10,471. 45 cts.

TRACTION in New York City, Competitive Systems of (Editorial review of the various systems and facts explanatory of the choice determined upon. 900 w.) Sci Am—Jan. 16, 1897. No. 10,435. 15 cts.

TRACTION on New York Street Railways, Compressed Air and Electric (Extract from the report of the Board of Railroad Commissioners of New York State for 1896, concerning the experimental trials on various lines. 600 w.) Eng News—Jan. 14, 1897. No. 10,457. 15 cts.

TRACTION Under Steam Railway Conditions, Electric. John C. Henry (The writer's convictions regarding the most desirable mechanical and electrical construction. 1,000 w.) Elec Eng—Jan. 6, 1897. No. 10,313. 15 cts.

MISCELLANY.

BROOKLYN Elevated, Annual Report of the (Review of the report and comment on projects designed to benefit the company's traffic. 1,300 w.) R R Gaz—Jan. 15, 1897. No. 10,463. 15 cents.

ELECTRIC Travel, The Age of. George Ethelbert Walsh (Explains how railroads came to develop so rapidly in this country and why electric traction has advanced. Discusses the probability of electricity taking the place of steam and the various sources of power to be developed, &c.) Chau—February, 1897. No. 10,671. 30 cts.

INCLINED PLANE Railways and Ropes. Samuel Diescher (Read at meeting of Engs. Soc of W. Penn. Describes these railways and their operation and discusses the deterioration of the wire ropes used. The history of a set of ropes is given. 5,500 w.) St Ry Jour—February, 1897. No. 10,735. 45 cts.

Books of the Month

Hutton, Frederick Remsen, E. M., Ph. D., The Mechanical Engineering of Power Plants. First Edition. John Willey & Sons, New York. 1897. Chapman & Hall, Ltd., London, 1897. Cloth, $5.00.

A book covering this broad field, and following all that has previously been printed on the topic, needs to be an extremely well and carefully prepared treatise not to suffer by a comparison with its predecessors. Of course, not a year passes without bringing forth something new in mechanism and methods. The latest book may, therefore, always contain something not contained in prior books; but, if this be its only conspicuous merit, it may still lack sufficient justification for intrusion into the literature of applied mechanics. In our opinion, the book under present notice has very much more than this slender claim upon the approval of the mechanical public. It treats upon perhaps the most important branch of mechanical construction in a masterly, exhaustive way that cannot fail to make it a valuable addition to every mechanical library. It is not merely a text-book of mechanical construction; it is a well-indexed work of reference as well. We have sought in vain in the table and index for the name of any typical appliance, or title of any minor topic related to the general subject, that is not treated. Two prominent characteristics of the work will, we think, place it among classical engineering treatises,—to wit, its classifications, and its comparisons of advantages with disadvantages inherent in different classes of types of engines and steam appliances. The work is printed in excellent style, and contains 750 octavo pages and 500 illustrations. We can recommend it not only to constructors, but to all students of mechanical engineering.

Ricketts, Pierre de Peyster, E. M., Ph. D., and Miller, Edmund H., A. M., Ph. D. Notes on Assaying. First Edition. John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1897. Cloth, $3 00.
Designed to replace "Notes on Assaying and Assay Schemes," published in 1876, and revised in 1879.

Much more rapid quantitative determinations are now made than were practicable two decades ago, and these new methods are included in the present treatise. Many of them have been outlined in the various journals, but, before finding a place in this book, each has been tested and found successful in the assay laboratory in Columbia School of Mines. The volume also embodies the work of assaying practised in Columbia University, as organized and developed by a series of able and successful instructors and professors who have successively had charge of the laboratory. Elegantly printed and illustrated, and well indexed, the work contains 311 octavo pages.

Stephens, W. P., Yachting Editor of *Forest and Stream*, Supplement to "Small Yachts." Forest and Stream Publishing Co., New York, 1896. Cloth, $4.00.

The author has selected the best examples to illustrate the changes since the publication of "Small Yachts," and has followed the course of "limiting the subject as closely as possible to models that appeal most strongly to the amateur yacht sailor, designer, or builder as being within his personal reach." He tells us in his preface that, "although the craze of every yacht constructor has been carried to the extreme, at the same time many and important improvements have been introduced; those details and forms, such as the carrying out of all the water lines fairly to the stem band rather than ending them at the jog at the rabbit,—details which pertain rather to practical building than to designing,—have been greatly refined, and, with improved materials and methods of using them, much useless weight has been cut away, and with a positive gain in stability and speed." The yachts illustrated and described with working drawings and details of construction include many which have been sailed in American waters during the past ten years. It is claimed that great pains have been taken to secure accuracy and completeness in details and dimensions. The book is a quarto, containing 104 pages of elegantly-printed text and 63 full-page plates.

Briggs, William. M.A. LL.M., F.R.A.S., and Bryan, G. H. Sc.D., F.R.S. THE TUTORIAL STATICS. W. B. Clive, London ; Hinds & Noble, New York, 1897. Cloth, $1.00.

We have previously had occasion to commend the admirable method of this excellent series of text-books in noticing other books in the course. That which will most impress the reader,—particularly if he be a trained and experienced teacher, —is the evidence of training and experience in teaching which is perceptible on every page of the several treatises. The text-book of statics, which forms an important link of the chain of works covering the subjects of mechanics, hydrostatics, dynamics, etc., includes such portions of the subject (a large portion) as may be treated without the use of the higher analytical methods. While a knowledge of trigonometry would be a help in the study of the earlier chapters of the treatise, this is not essential, as nothing more than some easily-learned trigonometrical definitions are involved. We have sought in vain among many dictionaries and treatises on physics for as clear, concise, and comprehensive definitions of terms as are given in this treatise. The definition of the term "moment" in the first paragraph on page 66 (in fifteen words), a term which many authors fail to make clear at all in a definition ten times as long, is an example in point. In short, it is the comprehension of the difficulties that students have in gaining clear conceptions of the meaning of terms that, more than anything else, manifests the skill as instructors of the authors of "The Tutorial Series." After what we have said, it is scarcely necessary to add that we most heartily commend the book, and the series of which it forms one part, to both students and instructors.

BOOKS RECEIVED.

Interstate Commerce Commission.=Preliminary Report on the Income Account of Railways in the United States for the year ending June 30, 1896. Prepared by the Statistician to the Commission. Government Printing Office, Washington, D. C. 1896. Cloth.

Report of the Commissioners of Education, 1894-95. Two volumes. Government Printing Office, Washington, D. C. Cloth.

Lee, Harry A., Commissioner of Mines. Report of Bureau of Mines, Colorado. The Smith-Brooks Printing Company, State Printers, Denver, Col. 1896. Cloth.

Irvine, R. C., Manson, Marsden, and Mande, J. L., Commissioners. Biennial Report of the Bureau of Ores for 1895 and 1896. A. J. Johnson, Superintendent State Printing, Sacramento, Cal. 1896. Cloth.

BOOKS ANNOUNCED.

Bower W. Frank. Specifications. A Practical System for Writing Specifications for Buildings. E. A. McLane, New York, 1896. Buckram, $5.00

Campbell, Harry Huse. The Manufacture and Properties of Structural Steel. Scientific Publishing Co., New York, 1896. Cloth, $4.00.

Lang, Herbert. Matte Smelting, its Principles and Later Developments. Scientific Publishing Company, New York, 1896. Cloth, $2.00.

Marshall, W. C. Course in Elementary Machine Design. The E. P. Judd Company, New Haven, Conn. Cloth, $1.50.

Weisbach, Julius and Herman, Gustave. The Mechanics of Pumping Machinery. A Text Book for Technical Schools and a Guide for Practical Engineers. Translated by K. P. Dahlstrom. Macmillan Co., 1897. Cloth, $3.75.

Rickard, T. A. Stamp Milling of Gold Ores. The Scientific Publishing Company of New York announce that they will soon issue this valuable work.

Hardy, H. Stained Glass as an Art; with a Colored Reproduction of the Drawing for the Creation; 20 collotypes, illustrated from designs by Sir E. Burne-Jones, W. B. Richmond, and the author. The Macmillan Co., New York, 1897. Cloth, $6.50.

Phillips, Arthur J. A Treatise on Ore Deposits; second edition, re-written and enlarged by H. Lewis. The Macmillan Co., New York, 1897. Cloth, $7.00.

Van Ormun, J. L. Assoc. M. Am. Soc. C. E., Special University Lecturer. Topographical Surveys, their Method and Value. Bulletin of the University of Wisconsin. Engineering Series, Volume 1, Number 10. Published by authority of law and with the approval of the Regents of the University. University of Wisconsin, Madison, Wis. Paper, 35c.

Boisot, Louis, Jr. A Treatise on Mechanics' Liens. Western Publication Company, St. Paul, Minn., 1897. Cloth or sheep, $6.00.

Coleman, T. E. Sanitary House Drainage; Its Principles and Practice. A Hand Book for the Use of Architects, Engineers and Builders. Spon & Chamberlain, New York, 1897. Cloth, $2.00.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Boston Belting and Packing Company, Boston, Mass.=Leaflet illustrating and describing "Excelsior" Self-Vulcanizing Packing, for air, steam, or water joints, and "Imperial" Self-Vulcanizing Packing, a special grade for extremely hard and trying places.

The Cincinnati Milling Machine Co., Cincinnati, Ohio, U. S. A.=Elegantly-printed catalogue, illustrating and describing very fully an excellent line of milling machines, and attachments therefor, with price-lists.

The Goheen Manufacturing Co., Canton, Ohio.=Pamphlet entitled "Information on the Preservation of Iron and Steel Structures"; being extracts from a book having the same title printed under permission of the author, Mr. William Broom; to which is appended by permission of Mr. C. E. Fowler, chief engineer of the Youngstown Bridge Co., a table of data relating to the painting of iron bridges, and another table showing the cost of keeping an eighty-foot railroad bridge in first-class protection for a period of thirty-two years.

The Waterbury Farrel Foundry and Machine Company, Waterbury, Conn., U. S. A.=Leaflets (*a*) illustrating and describing rolling-mill machinery; (*b*) tube and wire-mill machinery; (*c*) price-lists of presses, drop-hammers, screw-threading machines, lathes, etc.

The H. and V. Publishing Co., New York.=Catalogue of Books selected with reference to their interest to heating and ventilating, and allied industries.

George H. Olney, Brooklyn, N. Y.=Catalogue of Model Locomotives for 1896-'97.

Cunninghame & Co., Chicago, Ill., U. S. A.=Pamphlet entitled "Coal Washing by the Luhrig Process." Reprint of a paper read before the American Society of Mechanical Engineers, by J. V. Schaefer, M. E., and other additional matter pertaining to the subject. Illustrated.

The Hoppes Manufacturing Company, Springfield, Ohio, U. S. A.=Pamphlet illustrating the Hoppes live steam feed-water purifiers, and exhaust steam feed-water heaters.

The Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Pamphlets (*a*) describing and setting forth the advantages of Dixon's silica graphite paint, with testimonials substantiating statements, and (*b*) a collection of testimonial letters from users during a term of twenty-five years since the silica graphite paint has been on the market.

J. C. Sala, Successor to John Roach, San Francisco, Cal.=Illustrated catalogue and manual of civil engineers' and surveyors' instruments, with useful tables, illustrations, and descriptions of the latest improvements upon instruments of precision.

The Northwest Military Academy, Highland Park, Ill., U.S.A.=Catalogue for year commencing September, 1896.

F. E. Brandeis, Brooklyn, N. Y., U. S. A.=Illustrated and descriptive catalogue and handbook of instruments of precision for civil engineers, surveyors, and astronomers. Cloth, 50c.

The Ashcroft Manufacturing Company, New York.=Catalogue (revised for 1897) illustrating and describing a long line of instruments and appliances for procuring data needed in the practice of steam engineering, such as gages, recording gages, indicators, speed recorders, alarm gages, special steam boiler safety appliances, pipe-fitters' tools, etc.

Michigan Mining School, Houghton, Miss., U. S. A.=Catalogue for 1894 to 1896, inclusive, with statements concerning the institution and its course of instruction for 1896-1898.

Buffalo Forge Co., Buffalo, N. Y., U. S. A.=Royal octavo, four-hundred-page, library-bound catalogue, brought up to 1897. Contains, also, full exposition of the Buffalo fan-system of ventilation. Profusely and richly illustrated with cuts of appliances and machines, diagrams exemplifying applications, and half-tone engravings of buildings ventilated by the Buffalo system.

The Cincinnati Corrugating Company, Piqua, Ohio.=A circular relating to the first cost, freedom from repairs, effectiveness, fire-proofing qualities, and durability of the different roofing materials now on the market. Giving much valuable information that should be in the hands of all using or handling roofing of whatsoever kind.

W. A. Crook & Bros. Co., Newark, N. J.=Catalogue for 1897, consisting of 130 pages, liberally illustrated and showing all the latest improvements in hoisting engines adapted for every purpose. The firm represents that it covers the entire field in this class of machinery.

Avondale Marble Company, Avondale, Pa., U.S.A.=Pamphlet illustrating and describing the white marble of the Avondale Marble Company, setting forth its desirable qualities for building purposes, including its beauty of texture and color, its weathering qualities and strength.

The Phosphor-Bronze Smelting Co., Philadelphia, Pa., U.S.A.=Pamphlet describing the Delta metal or bronze manufactured by this company, and largely used for propellers and other purposes where resistance to corrosion combined with strength is a desideratum.

American Steam Gauge Company, Boston, Chicago, New York.=Pamphlet illustrating and describing the line of steam gauges manufactured by this Company, the Bourdon Steam Gauge, the American-Thompson Steam Engine Indicator, Amsler's Polar Planimeter and other instruments for the measurement of pressures, temperatures and strengths of solutions, and instruments for use on steamships in obtaining data.

Anthracite Coal Operators' Association, New York.=A Trade Report giving data and statistics of this Association.

J. Jones & Son, New York.=Catalogue illustrating and describing a long line of electric supplies, with price lists.

George Focht Iron Works, Hoboken, N. J., U.S.A.=Illustrated and descriptive catalogue of self-acting apparatus for conducting and conveying coal and other materials, with price lists, etc.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.=Announcement of a pocket edition size of the 400 page library bound catalogue of this Company. This book is said to contain three or four times as much data as is contained in the 1892 edition. On account of the great demand for the library edition the Company states that it has been compelled to file up requests for it until the reduced edition is ready for distribution. The text of the latter is a duplicate of the large book.

McGuire Manufacturing Co., Chicago, Ill.= Illustrated and descriptive catalogue of electric trucks, combination snow ploughs, and sweepers, street car heaters and other appliances for street railroading.

The Denver Engineering Works Company, Denver, Col., U. S. A.=Pamphlet illustrating and describing cars, gauges, skips, buckets, wheels, axles, and other allied goods for miner's use.

P. H. & F. M. Roots Company, Connorsville, Ind., U. S. A.=Illustrated catalogue of gas exhausters, gas valves, by-pass valves, automatic gas governors, pipe fittings, etc.

The Goheen Manufacturing Company, Canton, Ohio, U. S. A.=Pamphlet containing a short essay on the preservation of iron structures, and a paint table of total cost for 32 years of different kinds of paints and inclosing a piece of sheet metal painted according to the system of this company as a sample of the work done.

Ohio State University, Columbus, Ohio.=University Bulletin, giving full information in reference to the educational advantages of the institution and the qualifications necessary to be admitted thereto.

J. C. Speidel, Reading, Pa., U. S. A.=Pamphlet illustrating and describing dumb-waiters and hand-power elevators and other hoisting machinery.

Steam Users Association, Boston, Mass., U. S. A=.Pamphlet setting forth the purposes of the association, form for subscription to plans submitted, annual report and plan of work for 1897 ; also contains C. L. Norton's report of nonpareil cork pipe cover (supplement to circular No. 2). Circular 7 on mechanical stokers ; circular 8 economizers ; circular 9 combination in boiler furnaces.

The Gould's Manufacturing Co., New York. =Illustrated pamphlet containing remarks upon and capacities of Gould's electric pumps for raising water t othe upper stories of buildings.

Bangor Excelsior Slate Co., Easton, Pa., U. S. A.=Pamphlet describing the qualities of the well known Bangor Excelsior Slate for roofing purposes, with tabulated sizes of slate, the amount that should be exposed to the weather on the roof, the rule in lathing, and the number of pieces in each square.

The Northampton Works, New York.=Illustrated catalogue of dumping horse cars, sprinkling cars, etc., manufactured by Hobson & Co., Tatamy, Pa., U.S.A.

Kansas City Wheel Scraper Co., Kansas City, Mo., U.S.A.=Pamphlet illustrating and describing the Kansas City Wheel Scraper for road making.

Dry Dock Engine Works, Detroit, Mich., U. S.A.=Illustrated pamphlet describing the Howden system of hot draft.

The United Gas Improvement Co., Philadelphia, Pa.=Large illustrated quarto of 52 pages in stiff covers describing the appliances and methods of this company for the manufacture of water gas. The illustrations are unusually good and the text in connection with the cuts will give any one an excellent idea of the apparatus for manufacturing water gas.

The International Correspondence Schools, Scranton, Pa., U.S.A.=(a) Pamphlet describing the system of home study of coal and metal mining and prospecting issued by the Correspondence School of Mines (one of the schools named above) and setting forth the advantages offered by this school. (b) Pamphlet containing 1,000 testimonials from students of the International Correspondence School, Scranton, Pa., representing 74 States and countries of North America, South America, Europe, Africa and Australasia.

The Goodsell Packing Company, Chicago, Ill., U.S.A.=Illustrated and descriptive catalogue of the piston-rod packings, pump packings, etc., manufactured by this house.

American Road Machine Company, Kennett Square, Pa., U.S.A.=Illustrated pamphlet describing appliances for road making manufactured by this establishment.

The Card Electric Co., Mansfield, Ohio, U. S.A.=Large quarto pamphlet illustrating and describing the line of high grade, low speed multipolar electric machinery manufactured by this company, together with other electric appliances, regulators or resistances, controllers, etc.

Boston Belting Co., Boston, New York, Buffalo, New York, U.S.A.=Illustrated and descriptive catalogue of cotton and rubber garden hose, couplings, nozzles, couplers, sprinklers, reels and hose appliances.

The Pittsburg Boiler Scale Resolvent Co., Pittsburgh, Pa., U. S. A.=Pamphlet describing the Pittsburgh boiler scale resolvent, with price list.